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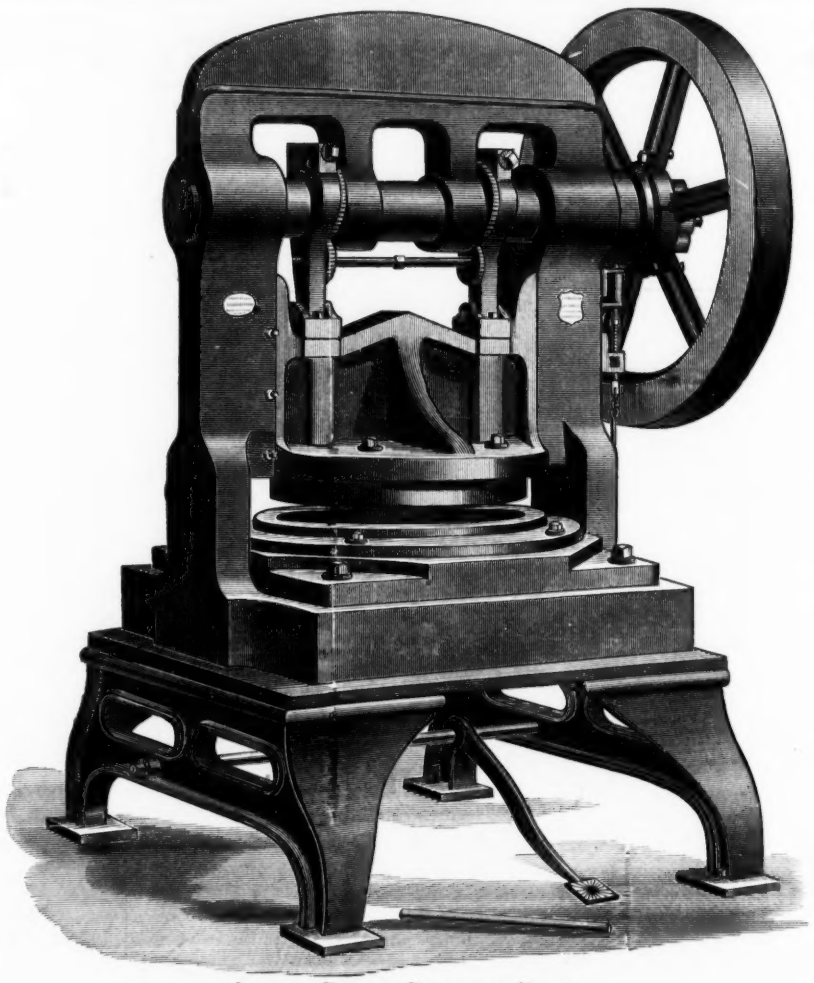
Double Pitman Blanking Press.

The first engraving on this page represents a new form of blanking press brought out by the Stiles & Parker Press Co., of Middletown, Conn., and called by them their double pitman press, for the reason that two pitmans are used for transmitting motion from the main shaft to the sliding head. The particular machine here illustrated is for dies up to 30 inches diameter, that being the distance between the slides, and the bedplate having a hole through it 31 inches square, to allow blanks of any shape up to 30 inches in size to pass through.

The die and punch shown in the machine are for making armature rings for electric work, for which purpose the machines are largely employed, though these and similar machines are used for any purpose where blanks up to 60 inches in size are required, the larger machines differing from the one illustrated only in having their frames made wider.

As will be seen, the machine is of the most approved design, the metal of the frame being disposed in straight lines between the points at which strain is applied. The stroke of these machines is fixed, but there is an adjustment for the slide by means of the same device used by this company in its regular punching machines, which consists of an eccentric fitted to the upper end of the connection, and arranged to be turned around in it and clamped in any position by the bolts seen passing through the connections above the shaft, the connection being split to allow of clamping when the bolts are tightened. The holes which pass through the eccentrics form the bearings for the wrist-pins, so that, when the eccentrics are turned about the shafts, it has the effect of raising or lowering the slide. In this case it is, of course, necessary that the two eccentrics should move together in order that the slide may always be exactly square, and this is effected by means of flanges at one side of each eccentric, on which teeth are cut that engage with spur gears shown below, both of which are on the same shaft, and are turned by means of a wrench applied to the hexagonal section in the middle. The amount of adjustment provided for in this way is one inch.

The clutch mechanism used on this machine is also the same as used on the other machines by this company, and includes a positive disengaging arrangement which leaves the slide always at the upper limit of its stroke.



DOUBLE PITMAN BLANKING PRESS.

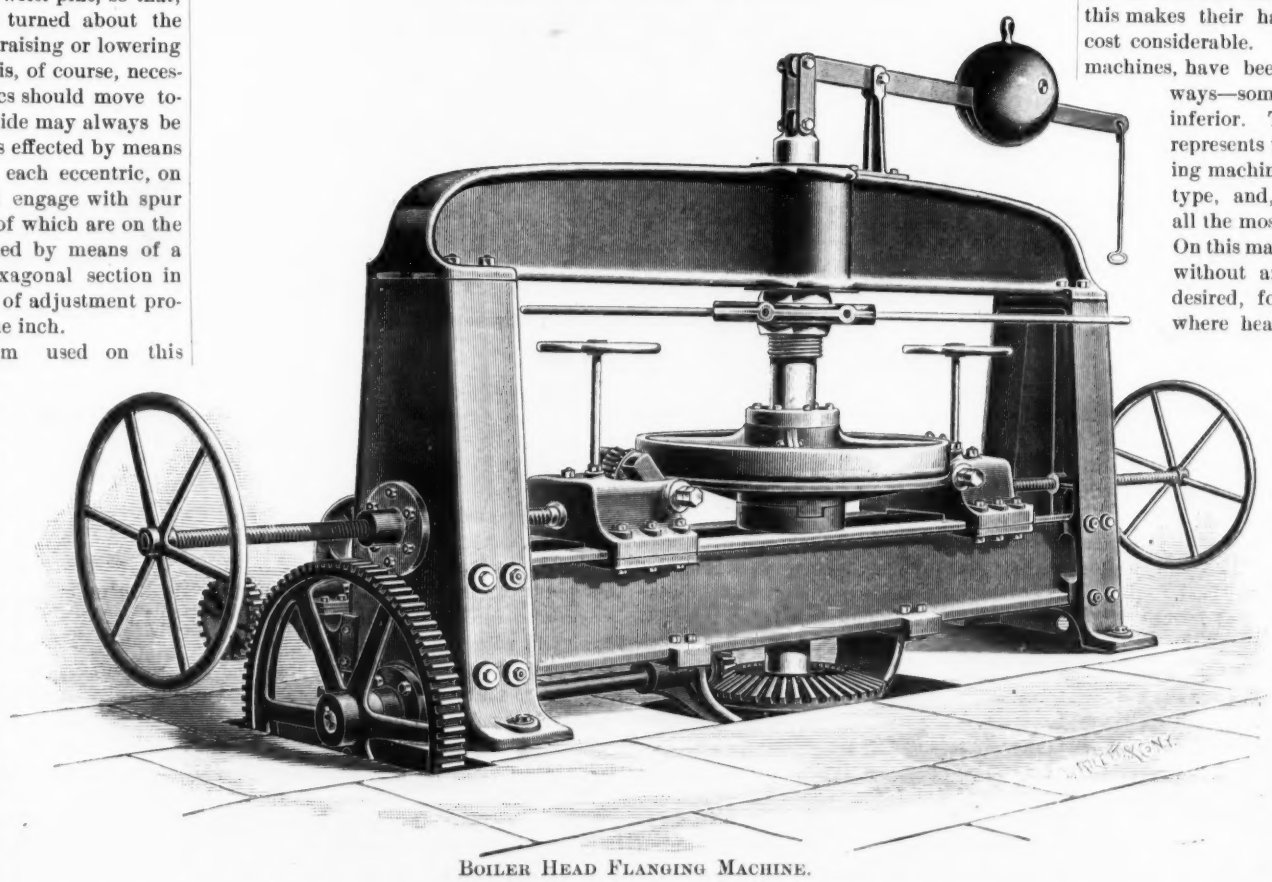
No strain worth speaking of comes on the shaft of this machine except at the moment of actual cutting by the punch, and that strain, of course, tends to lift the shaft in its bearings, so that any looseness caused by wear allows the punch to stop when it strikes the metal, until the lost motion is fully taken up. To avoid this a very ingenious method of adjustment is used, which acts always to lift the shaft vertically against the solid metal composing the upper part of the bearing, and thus no sacrifice of rigidity takes place. The adjusting device consists of circular wedges which lie under the shaft in each bearing, their inner faces being fitted to the shaft, while their outer surfaces, though cylindrical, are struck from a different center, so that, when forced around the shaft by the set-screws provided for that purpose, the effect is to lift the shaft. One of these wedges is placed in the frame of the machine at each side, the set-screws for adjusting them being at the back.

The dies shown in the machine punch out a disk, the center of which must be afterwards punched out to complete the ring; this form being usually employed for the reason that the rings for the different sized machines made by the same company are usually so proportioned that the outside diameter of one is just equal the inside diameter of the next larger, so that, after the punching of the first blanks, a complete ring is made at each stroke; but, where it is required, dies can be furnished which make a complete ring from the first.

The 30-inch machine weighs about 6,000 pounds, has a stroke of 1¼ inch, a fly-wheel weighing 1,400 pounds, with 7-inch face, and is calculated to be run at a speed of 75 to 85 revolutions. They are made in sizes from 24 to 60 inches.

Boiler Head Flanging Machine.

Flanging machines for boiler heads are of two classes: The "hydraulic" machines, operating on the principle of a press, and the "rotary" machines, on the principle of a spinning lathe. The hydraulic system has many advantages, and, if handled with any care, does perfect work. The heads being turned over formers or dies, absolute uniformity of size is insured, which, of course, is a most important feature. The principal disadvantage of the hydraulic system for the average shop is its first cost; then, too, the dies are of necessity made heavy, and this makes their handling difficult, and the cost considerable. The rotary, or spinning machines, have been constructed in various ways—some good and some very inferior. The illustration herewith represents the O'Brien patent flanging machine, which is of the rotary type, and, it is claimed, combines all the most important requirements. On this machine heads can be flanged without any formers at all, or, if desired, formers may be used; and where heads of a particular size are used in considerable quantities, this possibility of using formers is most valuable, and, for round heads, makes the machine fully equal to the hydraulic. On this rotary machine only one die is required when operating, in place of two, as in the hydraulic system; and this is a light casting, requiring no machining, thus being cheap and easily handled. Heads can be dished on this machine, and beveled flanges can be turned, tending either in or out, as desired. The capacity of this tool for turning out work depends solely on the furnace. It will flange all the heads which two furnaces will heat, and with one good furnace from 100 to 150 heads have been flanged in ten hours. The following



BOILER HEAD FLANGING MACHINE.

estimate is made by the manufacturer: "A flanging gang of three good men will possibly turn out five 60-inch heads in ten hours, using the fire all this time; say, for example, the men average $1.50 a day each, or $4.50 paid for labor on the five heads. Three unskilled men on the machine will turn these five heads with ease in half an hour. They would be of absolutely uniform size, perfectly round, and with no hammer marks. The men's time and the fire would be saved for the rest of the day; labor on the five machine-flanged heads about 22½ cents, or, if the men continued at the machine for the day, they would turn out at least one hundred heads of miscellaneous sizes, at exactly the same cost as the five hand-made heads. Figuring on this basis, the labor on the hand-made work would be about 90 cents per head, and on the O'Brien machine about 5 cents per head, showing a saving of 85 cents on each head, or $85.00 saved on the day's run. Now, allowing $10.00 for additional coal in larger fire necessary for the rapid heating, you have a net saving of $75.00 in one day, which will be more than sufficient to pay the interest on the cost of the machine for a year."

The operation of the machine can be described in a few words in connection with the cut. If the heads are to be flanged without the use of formers, the hot plate is clamped between two disks and rotated in a horizontal plane; vertical rollers are set at the required distance from the center to give the diameter head desired. The edge of the heated plate projects beyond these rollers a distance equal to the width of the flange, and, while it is revolving, oscillating rollers, carried by sliding saddles, are brought against it in nearly a horizontal position, and by means of hand-wheels seen above the saddles, the rollers are gradually brought to a vertical position by worm and worm-wheel, carrying the flange down around the inside rollers until it is flush and square, and the head is finished.

If flanging heads with formers the inside rollers are done away with, and the upper disk, supported by the large screw in the center, is replaced by a former of the required size, as shown in cut. The heated plate is clamped between this and the lower disk, with its edge just projecting beyond the former, and when put in motion it is bent up around it by the oscillating rollers. The nut under the upper beam then releases the large central screw, and the counterweight lifts the former out of the finished head.

No hole is made in the center of the heads, and, as indicated by the figures given above, the machine is very efficient, turning out flanged heads uniform in size, round, and free from hammer marks, at a rate and cost with which the best work done by hand is utterly unable to compete. It is being introduced by Mr. Jacob Clark, E. Washington avenue, Germantown, Philadelphia.

Stress in Structures.

In our previous examples we have considered the stress in frames which simply support a given load. The stresses in the different members of a simple lifting crane can be found by similar methods, but in doing so we must not lose sight of the essential feature of a crane, which provides for the raising or lowering of the load.

This feature of raising and lowering the load often changes the stress in the different members of the framework, and an examination of a few simple cases may be of interest to some of our readers.

Fig. 1 represents a framework similar to the common form of a crane; the means provided for the raising the weight is of the simplest kind; it consists of a fixed pulley, over which a rope is passed, the weight W being attached to one end, while the power is applied at the other end of the rope. In this figure the head piece $A\ B$ is horizontal, and the strut $A\ C$ forms an angle of 45 degrees with the head piece; the center line $E\ D$ of the hanger is vertical, or, in other words, perpendicular to $A\ B$. Now let the weight W be 2,000 pounds, and the power be applied at I in such a manner as will bring the two parts $I\ H$ and $F\ G$ of the rope parallel to each other, and let us further assume that the power at I just balances the weight W; it is required to find the stresses in the strut $A\ C$ and the head piece $A\ B$.

The stress in the rope is evidently equal throughout all its parts, consequently, under the given conditions, we may assume that there are two equal forces, $I\ H$ and $F\ G$, acting in directions parallel to each other, which tend to pull the pulley downwards. Now because these forces act parallel to each other their resultant must be equal to their sum; that is to say, the resultant is equal to $2{,}000 + 2{,}000 = 4{,}000$ pounds. Again, because the magnitudes of the forces are equal, the resultant will lie midway between them,

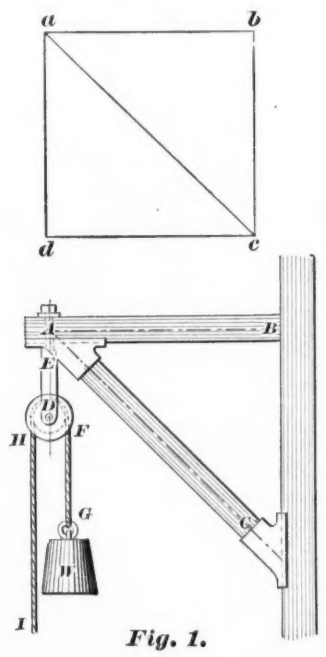


Fig. 1.

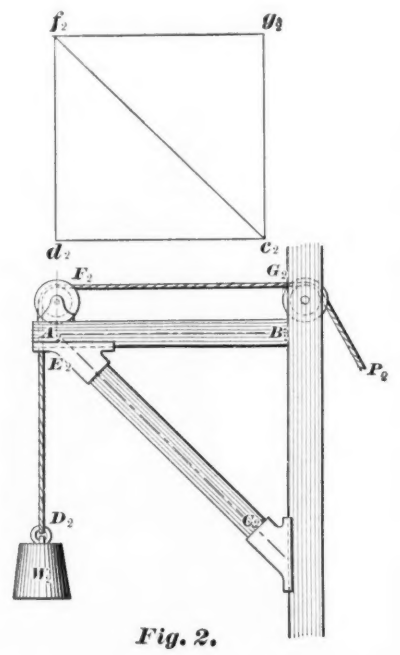


Fig. 2.

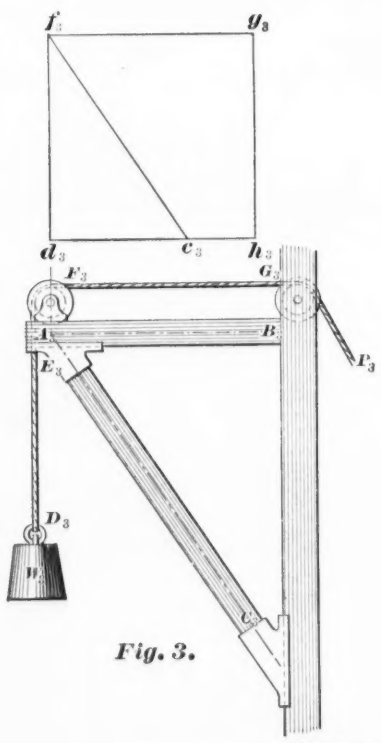


Fig. 3.

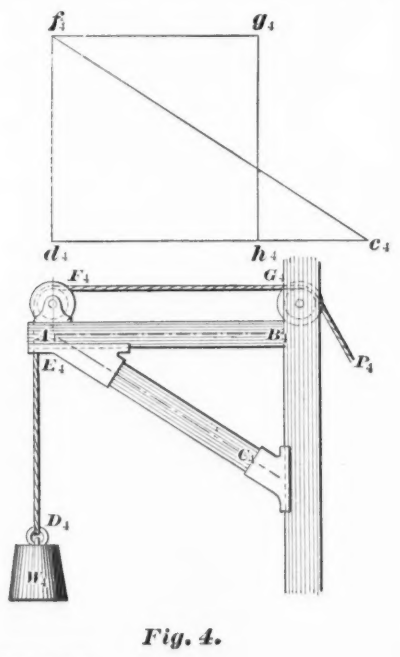


Fig. 4.

STRESS IN STRUCTURES.

and will also be parallel to them; hence the direction in which the resultant acts must lie in the line $E\ D$ prolonged downwards. The line $E\ D$ represents a force acting in the same line with the resultant, but in an opposite direction; and, since the system is in equilibrium, it follows that the magnitude of the force $E\ D$ must be equal to that of the resultant. We may now sum up the whole matter by saying that the raising of a weight of 2,000 pounds is equivalent to supporting a weight of 4,000 pounds at A, and the different members of the frame must be made strong enough to do so. Hence our problem is to find the stress in the members of the frame when a weight of 4,000 pounds is applied at A.

To find these stresses we again draw a parallelogram of forces as follows:

Draw $a\ c$ parallel to the center line $A\ C$ of the strut; from any point a in this line draw $a\ b$ parallel to the center line $A\ B$ of the head piece, and through the same point a draw $a\ d$ parallel to the direction in which the force applied at A acts, namely, $A\ D$. Now let us adopt a scale of equal parts with which the magnitudes of the forces can be laid off and measured; say we adopt a scale of which 1 inch represents 1,000 pounds. Since the line $a\ d$ is to represent the magnitude of a force of 4,000 pounds, we must make it four inches long. Through the point d draw $d\ c$ parallel to $a\ b$, cutting $a\ c$ in the point c; through c draw a line $c\ b$ parallel to $a\ d$, and thus complete the parallelogram of forces. Since the strut $A\ C$ makes an angle of 45 degrees with the head piece $A\ B$, the line $a\ c$ also forms the same angle of 45 degrees with $a\ b$, and therefore our parallelogram of forces is a square. The diagonal $a\ c$ represents the compression on the strut; measuring $a\ c$ we find it to be 5.656 inches long. Since each inch represents 1,000 pounds, the compression on $A\ C$ must be $5.656 \times 1{,}000 = 5{,}656$ pounds.

The tension on the head piece $A\ B$ is represented by the line $a\ b$, and, since our parallelogram of forces is a square, $a\ b$ is 4 inches long, and represents a tension of $4 \times 1{,}000 = 4{,}000$ pounds. Here then we find that if a weight of 2,000 pounds is to be raised as shown, the head piece must be made strong enough for a tension of 4,000 pounds, and the strut strong enough for a compression of 5,656 pounds.

Now let us examine Fig. 2. The frame itself shown in this figure is precisely the same as that shown in Fig. 1, but the means provided for raising the weight W_2 is different. Here the rope is passed over two pulleys in such a way that the portion $F_2\ G_2$ of the rope is parallel to the head piece $A_2\ B_2$; the weight W_2 is attached to the end D_2, and the power is applied at P_2. Let the weight W_2 be 4,000 pounds; it is required to find the stresses in the head piece $A_2\ B_2$ and the strut $A_2\ C_2$.

In this example, like in the last one, the stress in every part of the rope is the same. Since $F_2\ G_2$ is perpendicular to $E_2\ D_2$, we may assume that there are two forces of 4,000 pounds each, acting at right angles to each other, applied at A_2; these two forces are, of course, resisted by the head piece and the strut, and in order to find the stress in these members, we again construct a parallelogram of forces $f_2\ g_2\ d_2\ c_2$. The side $f_2\ g_2$ of this parallelogram represents the pull of the portion $F_2\ G_2$ of the rope, and the side $f_2\ d_2$ represents the pull of the portion $E_2\ D_2$ of the rope; since the tension throughout the rope is the same, the side $f_2\ g_2$ must be equal to the side $f_2\ d_2$; and if we use a scale of inches, each inch representing 1,000 pounds, $f_2\ d_2$ and $f_2\ g_2$ will be 4 inches long, and our parallelogram will be a square the same as in Fig. 1. The diagonal $f_2\ c_2$ makes, of course, an angle of 45 degrees with the side $f_2\ g_2$; and since the angle formed by the strut and head piece is also 45 degrees, the diagonal $f_2\ c_2$ is therefore parallel to the strut $A_2\ C_2$, and represents the compression in this member. The diagonal $f_2\ c_2$ measures 5.656 inches, hence it represents a compression of $5.656 \times 1{,}000 = 5{,}656$ pounds.

Now let us examine the condition of the head piece $A_2\ B_2$. The tension in this member due to the pull of the portion $E_2\ D_2$ of the rope alone will be 4,000 pounds, but the portion $F_2\ G_2$ of the rope tends to compress the head piece with an equal force; hence the head piece is not subjected to any tension or compression, and its duty is simply to steady the strut.

A comparison of Figs. 1 and 2 will show what effect the mode of raising a weight has on the framework. By raising a weight of 2,000 pounds as shown in Fig. 1, the strut $A\ C$ will be subjected to a compression of 5,656 pounds, and the head piece will be subjected to a tension of 4,000 pounds. By raising a weight of 4,000 pounds as shown in Fig. 2, the strut $A\ C$ will be subjected to a compression of 5,656 pounds, and the head piece will not be subjected to any stress, excepting that due to its own weight, and the little compression or tension which may be thrown upon it by steadying the strut $A_2\ C_2$.

It will be interesting to note the effect produced by changing the position of the strut. In Fig. 3 we have precisely the same framework as shown in Fig. 2, with the exception that in Fig. 3 the strut $A_3\ C_3$ forms a greater angle with the head piece $A_3\ B_3$ than is shown in Fig. 2. To find the stresses in these members under the new conditions, we again construct the parallelogram of forces $f_3\ g_3\ d_3\ h_3$, and, for the sake of easy comparison, the forces are laid off with the same scale as used in the other figures. The weight W_3 is 4,000 pounds. The side $f_3\ d_3$ of the parallelogram of forces, represents the tension in the portion $E_3\ D_3$ of the rope; and the line $f_3\ g_3$ represents the tension in the portion $F_3\ G_3$ of the rope, and since the tension in each portion of the rope is 4,000 pounds, the sides $f_3\ g_3$ and $f_3\ d_3$ represent 4,000 pounds each, hence they must be drawn four inches long, and the parallelogram will be a square, as before. Draw $f_3\ c_3$ parallel to the center line $A_3\ C_3$ of the strut, terminating in the point f_3, and the side $d_3\ h_3$. The line $f_3\ c_3$ represents the compression in the strut; it is 4.8 inches long, and therefore represents a compression of $4.8 \times 1{,}000 = 4{,}800$ pounds.

The tension in the head piece $A_3\ B_3$ due to pull of the portion $E_3\ D_3$ of the rope alone is represented by the line $d_3\ c_3$; it measures 2.65 inches, hence the tension in the head piece due to $E_3\ D_3$ is $2.65 \times 100 = 2{,}650$ pounds. But the portion $F_3\ G_3$ of the rope subjects the head piece to a compression of 4,000 pounds, which exceeds the tension, the excess being equal to $4{,}000 - 2{,}650 = 1{,}350$ pounds; therefore in this case the head piece $A_3\ C_3$ is subjected to a compression of 1,350 pounds. The amount of this compression is also plainly shown in the parallelogram of forces, for we know that the side $f_3\ g_3$ represents the compression due to the pull of

the portion F_3 G_3 of the rope; and d_3 c_3 represents the tension in A_3 B_3 due to the pull of the portion E_3 D_3 of the rope; the difference between the two is equal to c_3 h_3, which measures 1.35 inch, and represents a compression of $1.35 \times 1{,}000 = 1{,}350$ pounds.

Comparing Figs. 2 and 3 we find that in both cases the weight and the manner of raising it are alike, and that by changing the position of the strut we also change the stresses in the members of the frame. In Fig. 2 the strut is subjected to a stress of 5,656 pounds; in Fig. 3 it is subjected to 4,800 pounds. In Fig. 2 the head piece is subjected practically to no stress, and in Fig. 3 it is subjected to a compression of 1,350 pounds.

Lastly, let us examine Fig. 4. In this figure the angle formed by the strut and head piece is less than that shown in Fig. 2, otherwise the conditions remain the same as before; it is required to find the stresses in the strut A_4 C_4, and the head piece A_4 B_4.

Here the pull of the portion E_4 D_4 of the rope is again 4,000 pounds, and the pull of F_4 G_4 is also 4,000 pounds; hence draw the parallelogram of forces f_4 g_4 d_4 h_4, whose sides f_4 d_4 and f_4 g_4 are respectively parallel to E_4 D_4 and F_4 G_4, and since each of these sides represents a force of 4,000 pounds, and since they are to be laid off to the same scale as used for the other parallelograms, each will be four inches long. Through the point f_4 draw a line f_4 c_4 parallel to A_4 C_4, cutting d_4 h_4 prolonged in the point c_4. The line f_4 c_4 represents the compression in the strut A_4 C_4; its length is 7.3 inches, hence it represents a compression of $7.3 \times 1{,}000 = 7{,}300$ pounds. The line d_4 c_4 represents the tension in the head piece A_4 B_4 due to the pull of E_4 D_4, and the side f_4 g_4 represents the compression on the head piece A_4 B_4 due to the pull of F_4 G_4. The excess of tension over compression is represented by the line h_4 c_4, which in this particular case is 2.1 inches long, hence A_4 B_4 is subjected to a tension of $2.1 \times 1{,}000 = 2{,}100$ pounds.

Comparing Fig. 4 with Fig. 3 we find that by decreasing the angle between the strut and head piece we increase greatly the compression in the strut, and when this angle is less than 45 degrees the stress in the head piece will be a tension instead of a compression.

It is a common practice to make the angle between the strut and head piece of a common crane less than the angle of 45 degrees; this is done for obtaining more head room under the strut; but since this mode of framing increases the compression in the strut, and in some cases considerably, it is better practice, whenever circumstances will permit, to make the angle between these members a little greater than 45 degrees, as shown in Fig. 3.

The height of the pulleys above the head piece, as we have shown them, will make a slight difference in the stresses found; for the sake of simplicity we have not taken this height into consideration; in fact, in many practical cases it can be neglected without falling into any serious error.

The mode of joining one member to another will add but very little to the rigidity of the frame; it is therefore customary not to take the mode of joining the members into account, when simply the stresses in the members of structures are to be determined.

Reversing Gear for Small Yacht Engines.

Simplicity and compactness in the construction of engines is always desirable, hence, in small engines we often find the link replaced by some other design of reversing gear. Messrs. Riley & Cowley, builders of high-speed compound and triple expansion engines, whose works are at Richard and Bowne streets, Brooklyn, N. Y., have designed a reversing gear, illustrated in Figs. 1 and 2, and applied it to many small engines for steam yachts and launches. The device works very satisfactorily; it does away with half the number of eccentrics and rods, and is well adapted for small compound or triple expansion yacht engines, or engines used for other purposes.

In small compound engines, two eccentrics are placed close together and keyed to the sleeve A, which is free to rotate on the end of the crank shaft B. One of the eccentrics operates the valve of the low-pressure cylinder directly, the motion of the other eccentric is transmitted by means of a rock shaft to the valve in the high-pressure cylinder. The sleeve A has a spiral slot C cut in it, which engages with a pin D firmly screwed into a second sleeve E (part of this sleeve is shown in section in Fig. 2). The pin D also works in a longitudinal slot cut in the shaft B. In order to reduce the friction, the pin D is provided with two loose bushings, as shown in Fig. 1, one working in the slot C, and the other working in the slot cut in the shaft. A number of grooves are cut in and around the sleeve E, which engage with corresponding projections on the back of the rack G. This arrangement forces the sleeve E to rotate with the crank-shaft, and allows the rack to slide it along the sleeve A. The rack engages with a pinion keyed to the vertical rod; at the other end of this rod a hand-wheel is attached, so as to be in a convenient

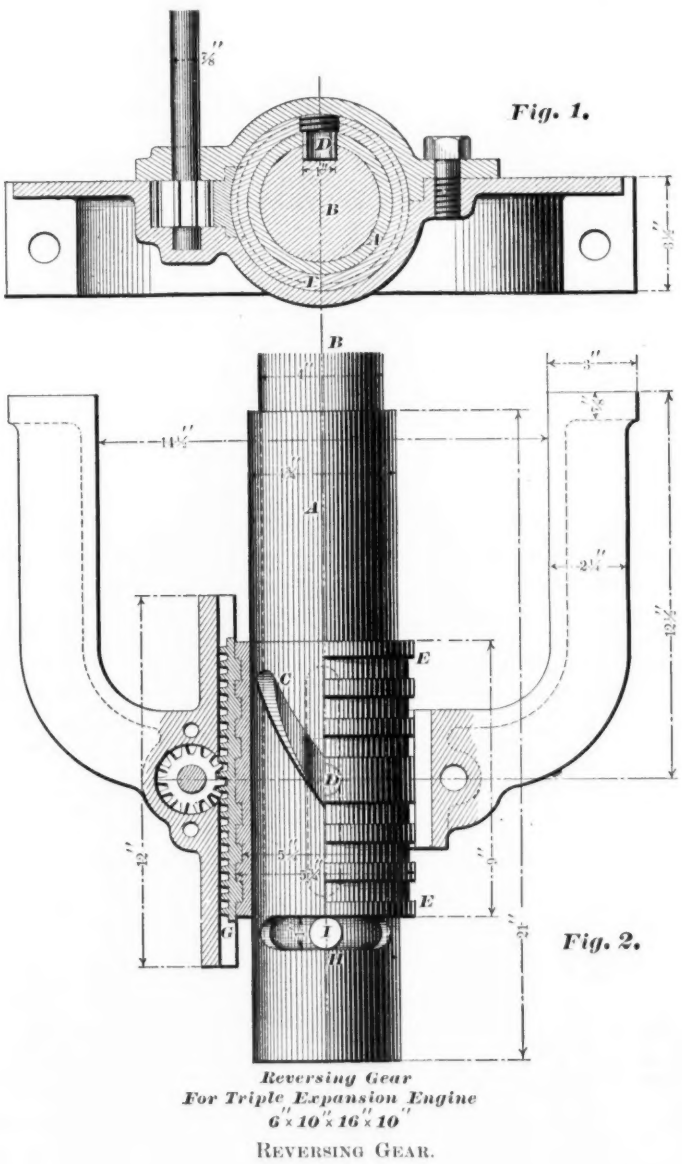


Fig. 1.

Fig. 2.

Reversing Gear
For Triple Expansion Engine
6" × 10" × 16" × 10"

REVERSING GEAR.

position for the engineer. In turning this wheel the rack is moved in its bearing, and causes the sleeve E to slide along the sleeve A. The pin D being firmly fixed in the sleeve E, and engaging with the spiral slot C, causes the sleeve A to rotate on the crank-shaft, and sets the eccentrics into a new position, thereby reversing the motion of the engine.

The pin I driven into the crank-shaft, and working in the slot H, serves as a stop, and prevents the eccentrics from being set over too far; this pin also prevents a longitudinal movement of the sleeve A on the shaft.

For a triple expansion the principle of the design of this gear is not changed, the only difference being that three instead of two eccentrics are keyed to the sleeve A. One of these eccentrics operates the valve in the low-pressure cylinder directly, as before, and the motion of the other eccentrics is transmitted by means of rock shafts to the valves in their respective cylinders.

In some of the larger engines it is sometimes necessary, for the convenience of the engineer, not to key the hand-wheel to the vertical rod, but to key it to a horizontal shaft, and transmit motion to the vertical rod by means of a pair of bevel gears.

Tall Chimneys.

The interest in structures of this kind has lately been increased by the account of the scaling of the damaged chimney of the Clark Thread Works, near Newark, N. J. A few notes on this subject may therefore be appreciated by many who may be curious on the subject.

The Clark chimney, to which the newspapers lately very generally referred as the tallest chimney in the world, is far from realizing this distinction; for, remarkable as it is for its great height, it is surpassed by one other in the United States, and by a number in European countries. We append the description of a chimney finished last October in Boston, for the service of the Fall River Iron Company, of that city, which, it will be observed, is 15 feet taller than the Clark chimney. Some idea of its size can be had from the following figures: From the top of the granite foundation to the cap is 350 feet; the diameter at the base is 30 feet, at the top 21 feet; the flue is 11 feet throughout, and the entire structure rests on a solid granite foundation, 55 by 30 feet, and 16 feet deep. In its construction there were used 1,700,000 bricks, 2,000 tons of stone, 2,000 barrels of mortar, 1,000 loads of sand, 1,000 barrels of Portland cement, and the estimated cost is $40,000. It is arranged for two flues, 9 feet 6 inches by 6 feet, connecting with 40 boilers, which are to be run in connection with four triple-expansion engines of 1,350 horse-power each.

In erecting this immense shaft no outside staging has been used, but as the work progressed cross-pieces were set into the inner wall, and on these a platform laid for the time being. All material was carried up on an elevator, and self-closing hatches precluded the danger of either workmen or material falling from above, while, by speaking-tubes and a system of electric signals, communication was established between the workmen and those below.

It is circular in form, and, to insure it being built absolutely plumb, observations were taken with a transit at a point 400 feet distant, and the true center verified every 20 feet the work was carried up. The cap is of terra-cotta, in 128 sections, and below this a distance of 25 and 50 feet are projecting rings; between these is the narrowest point in the diameter of the shaft, 15 feet 4 inches.

Following this in size is the much-talked-of chimney of the Clark Thread Works at Harrison, N. J., 335 feet high, and 28 feet 6 inches at the base.

Of finished chimneys there are three in European countries that considerably exceed both of these in size, as the following data will show. It should, however, be observed that all of these are designed not primarily for draught of boilers, as those above described are, but are used in connection with chemical works, where high shafts are essential to carry noxious gases and odors off without endangering the public health. That at Townsend's works in Glasgow, Scotland, is 454 feet high and 32 at the base; that is the height of the brick-work, but owing to the fact that it was struck by lightning, and somewhat damaged, as a precautionary measure a copper extension subsequently was added to it, making its entire height 488 feet. In order to get a man up to do this work a kite was flown over the chimney, and a line dropped across. Then a rope was hauled by this means over, and thus the workman was pulled up, to whom the copper sheets were hoisted one at a time, and who did the perilous job at the top alone.

When this was building and nearly finished a heavy gale canted it nine feet out of plumb, but this was remedied by sawing into the mortar on the side from which the stack leaned, until the immense shaft gradually settled back to its former position. It was three years building, and cost $40,000.

The next highest is at Tennant & Co.'s, also in Glasgow. This is 435 feet, 40 feet base, 13½ flue, and was one year building.

The third structure is that of Dobson & Barlow's, Bolton, England. It is 367 feet 6 inches high, 33 feet 10 inches at base, 13 feet 2 inches flue, and cost $15,000.

There is now in course of construction, near Frieberg, in Saxony, a chimney which will surpass all others. This is being erected in connection with the imperial foundry of Halsbrucke, and is also intended to disperse the deleterious gases that would otherwise be destructive or obnoxious to the neighborhood. The height of this structure will be 452.6 feet, and its interior diameter 15.74 feet. It was designed by the engineer Herr Huppner, and is situated on the right bank of the Mulde, at an elevation of 219 feet above that of the foundry works, so that its total height above the sea will be no less than 711¾ feet. The works are situated on the left bank of the river, and the furnace gases are conveyed across the river to the chimney on a bridge, through a pipe 3,227½ feet in length. This chimney is built throughout of brick, and will cost 150,000 marks, or about $40,000.—*Manufacturer and Builder.*

"The Gamble in Pig-iron" is what *Engineering* calls the processes by which the consumer and dealer have been kept apart in Britain for the past few months. And in its usual clear manner it shows the bad effect of such gambling.

Simple as A B C.

The Boston *Post* says of the Keeley motor: "Now that its secret is known, every one will wonder why he didn't think of it long ago. It is this: 'There is a triple sympathetic order of vibration diverting the positive and negative currents to one general and polarized center, the rotary action being continuous when sympathetically associated with the polar stream.' Nothing could be more simple, and the only wonder is that Keeley managed to keep it secret so long."

Fig. 5.

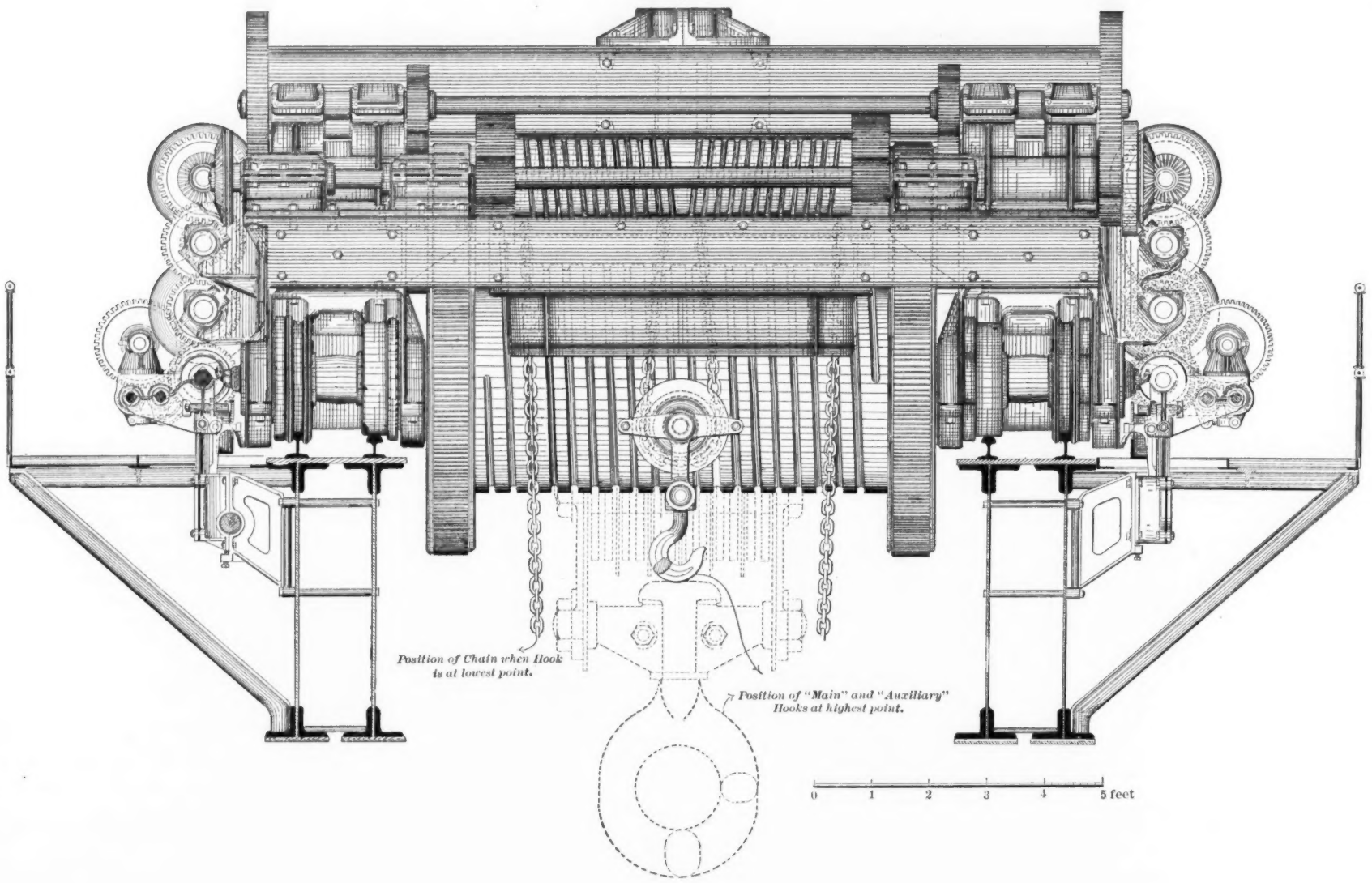
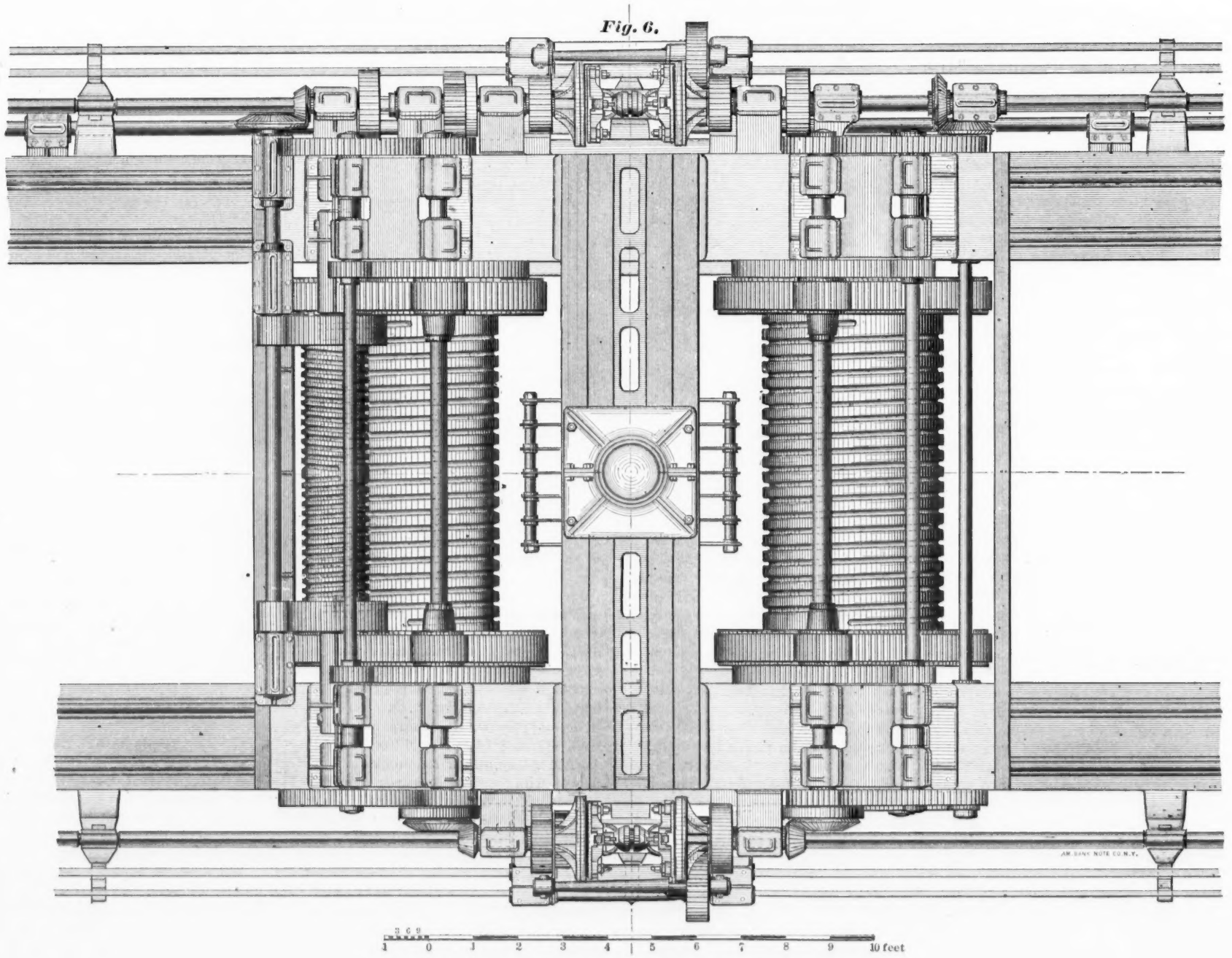


Fig. 6.



THE LARGEST TRAVELING CRANE.—SEE PAGE 5.

The Largest Traveling Crane.

Continuing from last week our description and illustration of the 110-ton (gross) traveling crane, Fig. 5 (page 4) gives an end view of trolley with transverse section of crane bridge at maximum depth in center, the lower chain sheave block (in dotted lines) at its highest point within the crane bridge, the auxiliary hoist mechanism and relation of miscellaneous parts.

A general plan of the trolley is given by Fig. 6, which shows it in position on the crane bridge, while Fig. 7 gives two views of the chain sheave blocks, showing the manner of roving the chain through the sheaves and coupling to the main drums. At *S S* are conical roller bearings supplied with rollers of hardened steel, which bear the weight of the load, and allow it to be turned easily when suspended. It will be noticed that the chain is rove through the blocks in such a manner as to allow the ends to be coupled diagonally to each drum, thereby causing the strain on trolley and girders to be at all times symmetrical when hoisting and giving an absolutely vertical lift throughout. The chain is of 1¼-inch iron with short links, the total length of chain being 600 feet. The chain drum for the independent hoist motion is 5 feet 10 inches long, 18 inches diameter, grooved right and left for ¾″ short link crane chain. Chain is coupled with both ends direct to each end of drum, and has clear lift of about 60 feet. The main chain drums hoist 41 feet clear lift.

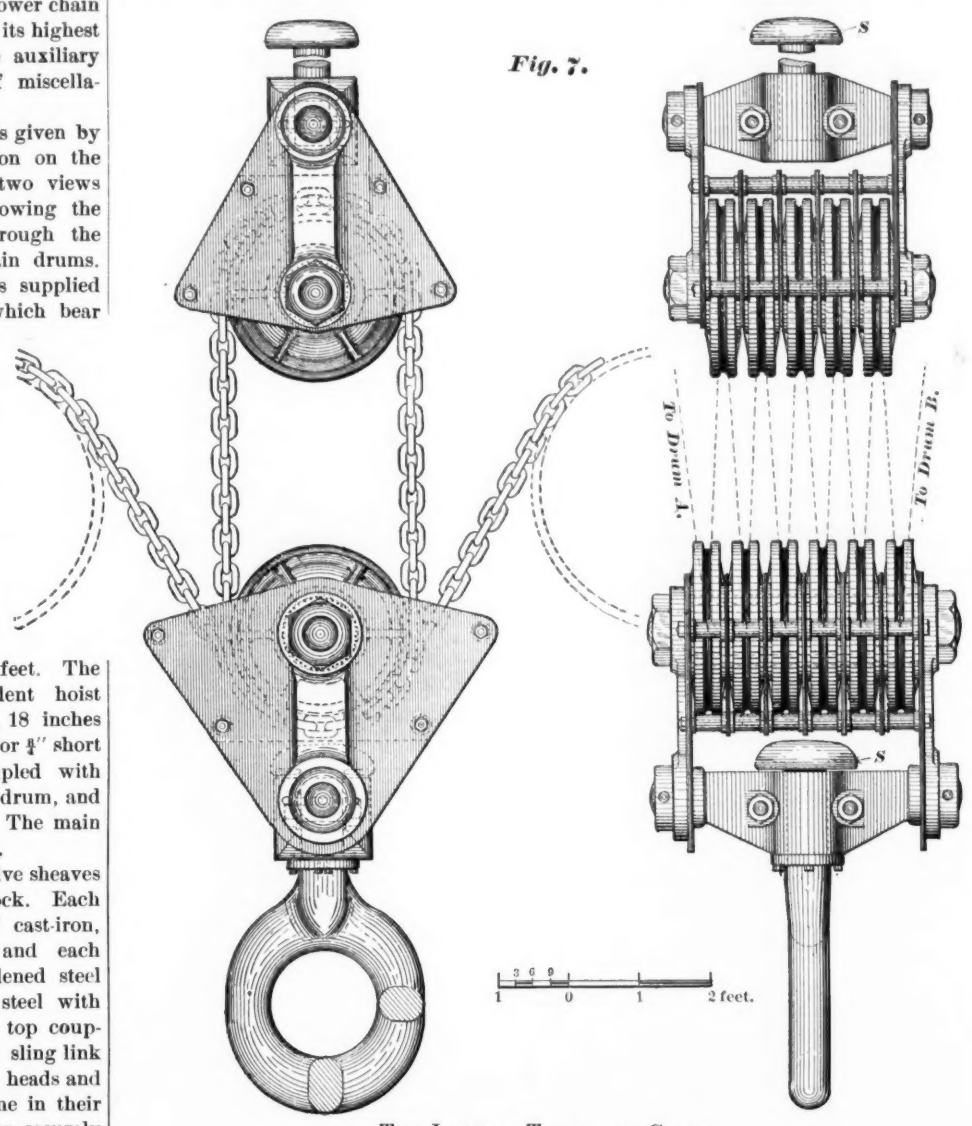
The chain sheave blocks have five sheaves in top block and six in bottom block. Each sheave is 30 inches diameter, of cast-iron, steel bushings hardened in oil, and each sheave revolves loose upon hardened steel roller bearings. Side plates of steel with forged wrought-iron links. The top coupling link pin for trolley beam and sling link in bottom block have forged steel heads and transverse beams, supporting same in their sheave blocks, are divided in halves, securely bolted, keyed and finished together. The total weight of chain sheave blocks and sling link is about 16 tons.

The 3-inch square shafts parallel with crane bridge are supported by four "Morgan" automatic drop bearings on each side of crane bridge, which are positive and noiseless in their action in raising and lowering, to allow trolley to pass and re-pass on bridge. The respective speeds of these square shafts are 75 and 150 revolutions per minute. One of these shafts to drive main hoist only. One to drive trolley travel and auxiliary hoist only. In addition to these parallel shafts there is a 4-inch diameter shaft for driving two sets of duplicate gearing, one set on each end truck for propelling longitudinal travel of crane squarely on track. This shaft is held in adjustable bearings secured rigidly to one side of crane bridge.

The main trolley frames are of cast-iron, box section, and weigh about 7 tons each. The main axles are hammered steel shafts, 15 feet 6 inches long, 7 inches diameter, and revolving loose thereon are the two grooved chain drums, 7 feet 6 inches long, 4 feet diameter. Each will wind about 260 feet of the chain. These drums are driven at each end by half-shroud spur wheels, 6 feet diameter, 10 inches face, 3 inches pitch, with steel pinions 13⅜ inches diameter, 10 inches face, 3 inches pitch. All shafts are driven at both ends. All wheels less than 2½ inches pitch and under 40 inches diameter have cut teeth. Powerful friction clutches for reversing and changing speeds are designed specially for this crane, being made under the "Frisbie" patents, specially adapted to this service, and made by the Morgan Engineering Company.

The trolley is carried upon sixteen 24-inch diameter steel track wheels, divided into four separate trucks, each having four wheels, and composed of two steel equalizing beams, fulcrumed on each main axle or chain drum shaft. These wheels have hardened steel roller bearings. The driving steel spur wheels have 6 inches face, 2 inches pitch, cut teeth.

Fig. 7.



THE LARGEST TRAVELING CRANE.

The transverse bridge beam on trolley frame is composed of four 20-inch heavy section steel I beams, built up as shown, for sustaining main chain sheave blocks and load. This bridge, at each end, rests upon bracket bearings on trolley frame, having a convex and concave surface similar to end trucks supporting crane bridge, the object being to allow deflection of bridge when sustaining maximum load, and prevent binding of trolley frames against machinery.

When in place the crane is to be driven by a 12-inch double-belt driving onto a 48-inch pulley, but during the tests made in the shops of the builders it was driven by electric motors, which had been constructed for other cranes, the bridge being mounted upon suitable supports on the floor of the erecting shop. While running in this way a representative of this paper was given an opportunity of observing its motions while standing on top of the moving trolley. Of course the movement of the bridge on its supporting girders could not be produced in this way, but all other motions were, and the action was in every respect admirable—smooth, quiet, and under perfect control. The prompt action of the brakes was especially noteworthy, they being instantly applied whenever the driving gear controlling the hoisting was thrown out, and as promptly released when hoisting or lowering. The arrangement is such that, should any connection between the operator and the brakes become broken or disconnected, the brakes are automatically applied.

Electrical instruments applied for the purpose of testing the power required to drive the machinery under the circumstances mentioned, and with every available motion, driven at its fastest speed, showed that about 30 horse-power were required, that is, for all motions except travel of bridge on girders, and with no load suspended. The total weight of the crane complete is about 200 tons, and sixteen freight cars were required to ship it to its destination. Altogether we think it will be conceded that this crane is a decided credit to its designers and builders, and that it marks a distinct advance in American engineering skill.

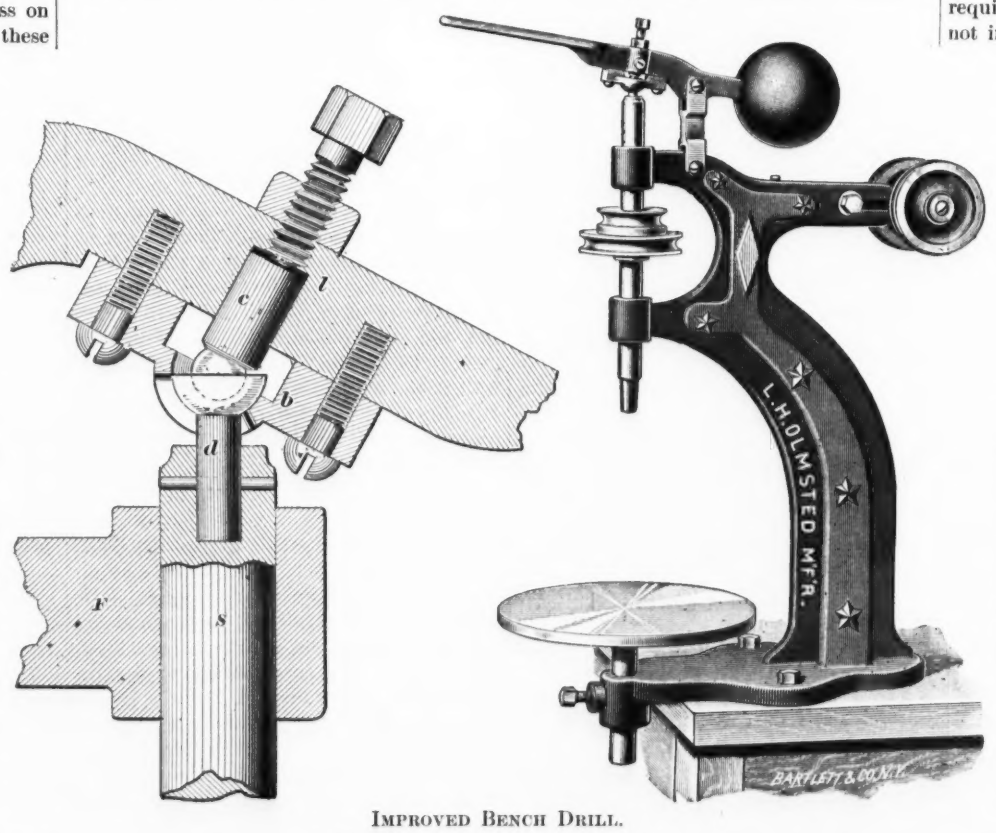
An Improved Bench Drill.

We illustrate herewith a small drill press intended to be set on a bench, and for drilling holes up to and including $\frac{5}{16}$ inch diameter. The principal point of interest in the machine is the method adopted for giving vertical motion to the spindle, which will be understood from the detail cut, in which *S* is the spindle, which has fastened in its upper end, by a pin, the steel piece *d*, which is shaped into a spherical cup at the top, which receives the ball on the end of the piece *c*.

This piece *c* is fitted to the lever *l*, by which the feeding is done. The outer surface of the cup is also spherical, and is fitted to a cup formed in the piece *b*, which is fast to the lever. It will now be apparent that any lost motion, which may occur from wear in any of these surfaces, can be taken up by turning the set-screw, forcing *c* downwards, and since the lever is free to move forward or backward (as it is mounted in a link), the thrust on spindle will be, for the short movements required, practically vertical, the only side thrust being that caused by the angle which the link may at times assume with the spindle, which would hardly be worth noticing.

The lever and spindle are accurately balanced by the weight shown, and as there are no sleeves or other mechanism to interfere with the free motion of the spidle the drill is rendered very sensitive, any extra resistance being instantly felt.

A round belt is used, and there are two speeds, the idler pulleys at the back being adjustable to secure the proper belt tension. Pulley on the spindle is keyed fast, and moves with the spindle, the small movement required for the work intended to be done not interfering with the action of the belt.



IMPROVED BENCH DRILL.

Spindle is of steel ⅝ inch diameter, and can be adapted to any drill chuck; table is 7 inches diameter, and can be adjusted vertically, 3 inches; distance from center of table to frame, 4½ inches. The whole height of the machine is 2 feet, and its weight 22 pounds. The builder is L. H. Olmsted, Hasbrouck Heights, N. J.

What with running into rocks and breaking down of machinery, the great Atlantic liners are having a rather serious time of it. Fortunately no loss of life has occurred, which speaks well for the construction of these vessels. The "perils of the deep" in a transatlantic voyage have almost come to be things of the past. The wisdom of the compartment plan of construction was well exemplified in the instance of the "City of Rome," which struck Fastnet rock. It is found that a hole twenty feet long was stove in her plates, and experts say but for the closing of the compartment door, thereby confining the water to one compartment, she would have instantly gone to the bottom.

John Wiley & Sons, New York, have in preparation "Mechanics of the Machinery of Transmission," being vol. 3, part 1, sec. 2, of "Mechanics of Engineering and Machinery," by Dr. Julius Weisbach, edited by Prof. Gustav Hermann, and translated by Prof. J. F. Klein, of Lehigh University.

LETTERS FROM PRACTICAL MEN.

Dipping Brass.

Editor American Machinist:

In Question 200, May 29, Reader, Rochester, N. Y., asks for a recipe for a solution to dip brass work in, preparatory to lacquering. He should boil the brass pieces in a solution of cream of tartar (bitartrate of potassa), rinse in warm water, and dry quickly; do not touch with the fingers. Warm the pieces and lacquer at once. The pieces will preserve a beautiful polish, and will not run the chances of becoming mat or frosty, as is likely to happen when nitric acid has been used. A. E. DUPAS.

Preserve the Eyes.

Editor American Machinist:

We send you by mail a pair of glasses worn in our factory when the operative was grinding on the emery wheel. These glasses show the force with which particles of emery are apt to strike the eye, and explains clearly why it is so difficult for the same to be removed when once imbedded in the eye. A trifle spent for such glasses prevents an immense amount of trouble and pain, besides saving the eyes of the workman. This may be of interest to your readers.

Vineland, N. J. GAGE TOOL CO.

[The glasses referred to are not only cut as if subjected to a sand blast, but the particles of emery appear to have imbedded themselves almost immovably in the glass.]

Water Lines.

Editor American Machinist:

In your issue of June 5th I read with interest Mr. Smith's article on "Corrosion of Gauge Glasses." It is the experience of the writer that the best way to take care of a gauge glass is to take it off and put it in safe keeping under lock and key, and then put on a high and low-water level column, of the best make, the needle of which will be found a far better sight indicator of the water level in a boiler than any gauge glass can be.

Those who have the needles in use never want to be without them. They never get out of order, the floats don't give way, and if they did, the needle would call attention to that fact by its position. I believe the time is coming when no well-equipped boiler will be without an indicating needle, and the gauge glass and its various troubles become a thing of the past. The electrical attachment can be put on at will, to give alarm and indication at any distance from the boiler. These are facts all steam users should know. M. P. JANNEY.

Grinding Lathe Tools.

Editor American Machinist:

I have been using a device for grinding lathe tools for several months, and find it works first-rate on the small sizes I use ($\frac{3}{16}$ x $\frac{1}{8}$ and $\frac{1}{4}$ x $\frac{3}{8}$); I don't see why it wouldn't work on larger sizes. Those of your readers who like to have their tools ground at certain angles which they have determined to be best, may, perhaps, be interested in this rig, so I will inflict it on them.

I fastened a small strip of sheet brass to one of the bearings of my emery grinder, graduated as shown in Fig. 1. If a tool is to have 10° clearance, it is placed on the table, and the latter is elevated or depressed until the cutting point of the tool is at the same height as the 10° mark, when the table is clamped. Now, if the tool is rested fairly on the table while the cutting edge is traversed back and forth across the cylindrical face of the wheel, the 10° clearance will be obtained. The graduations on the scale are obtained thus: The mark corresponding to any angle is at a distance above the center of the arbor equal to the sine of that angle multiplied by the radius of the wheel. This gives the tool a hollow face, of course, but it is only the extreme cutting edge we are interested in, and that's the part that gets the 10° clearance.

This method is only approximate, for, as the wheel wears down, the divisions on the scale would be too coarse. This source of error could be lessened somewhat by having several scales graduated for wheels of different sizes, each scale being made to do duty for wheels a little larger, and also a little smaller than the size for which it is correct. My wheel don't wear very rapidly, however; it is a Norton wheel, $\frac{3}{4}$ inch face, and I have been grinding all my tools on it for nearly three years; in that time it has worn down from 6 inches to $5\frac{11}{16}$.

The scale is fastened to the box-cap by a single screw, the groove filed in the back of the scale preventing it from tipping over sideways (Fig. 2).

In order to grind the rake on the top face of the tool, it is necessary to lay the tool on its side, and adjust the table while the tool is in that position. I made a crescent-shaped table to reach from near the back of the wheel clear around the front, and over toward the scale. The reason for this is that the top faces of ordinary front tools and right-hand side tools are more readily ground at the back of the wheel, when the wheel is placed on the left-hand end of the arbor, as shown. (I kept the right-hand end for other purposes.)

One thing I discovered, after using this method some time, was that the tool could be pressed against the wheel considerably harder without danger of drawing the temper than when held by hand on the ordinary T rest. This is probably because the pressure is distributed equally all over the surface being ground, while, if the tool is held free-hand, the tendency is, as some writer has said, to "grind the tool where it is dull," by lifting up the back end; this

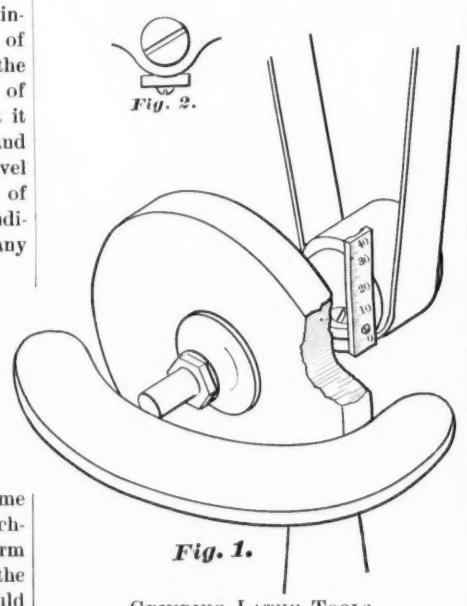


Fig. 2.

Fig. 1.

GRINDING LATHE TOOLS.

not only spoils the shape of the tool, but brings nearly all the pressure, and its resultant heat, on the extreme cutting point of the tool, where there is very little stock to absorb the heat.

If a workman maintains the angles of his tools at something near what they ought theoretically to be, he will be apt to get the greatest amount of work out of them with the least amount of grinding and forging. This rig has enabled me to do something in that direction, and I offer it to others for what it may be worth.

WALTER GRIBBEN.

A Question in Ethics—Lifting Water Forty Feet.

Editor American Machinist:

A case recently came to view that recalled indirectly some observations on "Machine Shop Ethics" made by "Jarno" many months ago, and, he being quite an ethical chap, I would like his opinion on the subject. In a certain tool-room, not many miles from Philadelphia, a drill chuck was found one morning carelessly broken, and inquiries forthwith started to discover, if possible, the guilty party. All efforts failed, each one claiming he knew nothing of it, endeavoring to shield the careless one. This rather angered the man in charge, and so, instead of charging it to one man, as was the general rule, he divided it among the men, making each pay a share of the cost of repairs. Now was it right for each of the innocent men to deprive himself and family of the amount deducted, even though it was small, for the sake of being called a "good fellow" by the "smasher"?

Some will, no doubt, object to the fining system as unjust, but it seems to be only fair, all things considered. Nothing seems to so refresh a man's memory as to the importance of taking a little care of tools or other articles under his care as being obliged to pay for them if he carelessly breaks or loses them or some part of them.

Tools will break, we all know; but when a man keeps breaking tool after tool with no apparent cause, a little investigation is in order, and no better way than fines, or rather paying for damage done, has come to my notice. Of course many will leave the job in preference to footing bills for which they are responsible, and rail at the "grasping hand of fortune," but even corporations have a limit to funds, and must protect themselves.

Some time ago W. H. Booth wrote about lifting water forty feet or more, and Coleman Sellers followed with some historical points on the same question, which seemed to show it was possible; but Mr. Bullock's suggestion to examine the tape line was opportune, to say the least. If this high lifting of water by the admission of air into the suction pipe were an established fact, or practical, why is it not adopted, and why does not Sellers or any other injector or pump maker's instructions for setting up instruments make a decided point of leaving "just a pin hole" in the suction pipe? None that I have ever seen on the subject even mentioned it; on the contrary, they say that "suction pipes must be kept perfectly tight." If there is anything in the "mixed water and air" theory, some of our best engineers ought to know, and ought to tell us too. Until many more come forward in its support, with data proving the same, the most of us will side with Mr. Bullock, and our own experience.

FRED H. COLVIN.

Internally and Externally Fired Boilers.

Editor American Machinist:

Under this heading Mr. Robb discourses on boilers in the AMERICAN MACHINIST of March 13th, and he raises the question of porosity of brickwork—a question I have myself raised in your columns, and one which I am confident deserves particular consideration. Mr. Robb refers particularly to the very general use of internally fired boilers in England. As a fact, the externally fired boiler is rarely seen here, excepting at a colliery, where the large surface of fire-grate, with its brick walls, is favorable to the combustion of inferior coals and dross, whilst the internal fire-box is better suited for good coal.

By the boiler insurance companies, however, the firing of a steam boiler upon its outer shell is not considered a particularly safe practice, and yet in America one finds single riveted steam boilers fired externally, and worked at pressures exceeding what is thought fit on this side for double-riveting, whilst on some steamboat boilers on the Mississippi or its tributaries still higher pressures are allowed by the United States Government regulations. The insurance company's objections do not, in my own opinion, go for much when the feed water is clean, and free from deposit; but where liable to deposit scale or mud the tendency to overheat the shell exposed to it to a tensile stress is enough to warrant caution, and call for some form of boiler where deposit can find a lower place for settlement than a surface directly exposed to fire.

In pondering these questions it has often occurred to me that the position of American boiler insurers must be far less easy than that of English insurers, who have really an excessive margin of safety in very many cases.

As regards economy, Mr. Robb is undoubtedly quite right in believing that air leakage at wrong places is a very serious cause of loss.

Dry brickwork is so very permeable to air, that, with an ordinary chimney draught, air must be pouring in volumes through every brick, to say nothing of bad mortar joints, and it may well be supposed that it would pay to insert a thin sheet of common iron in the middle of all such brickwork, so as to really enclose the furnace in an impervious box. As a cure for porosity, I have already advocated painting or tarring the external surfaces of brickwork to choke the pores, just as I would always tar the injection-pipe of a condensing engine to improve the vacuum.

The chief fault of the ordinary return tube boiler, as so commonly used in America, seems to me to be the placing of a thick cluster of tubes right above the steam-generating surface. The flue tubes must often offer great resistance to the free escape of steam, and greatly impede good circulation of water.

It is better to omit the central two rows of tubes, so leaving a clear vertical passage for the upward flow of steam and water from the furnace plate? In present practice, as the pressure in the bottom of the boiler is greater by some two pounds than it is in the steam space, it naturally follows that water may rise from the heated plate at the boiler bottom, which will become steam as it ascends to the surface, for at a pressure of say 60 pounds by the gauge, a difference of two pounds pressure may imply as much as four degrees of temperature difference, which means that, as the water enters between the flues, the diminished head upon it will allow it to flash partially to steam, which it will then do in contact with the flue tubes; and by providing the central space we induce all ascending water to go by this—the easiest—way, and so we may so promote circulation as to prevent entirely the actual formation of steam upon the heating surface over the fire. In a word, if we get so rapid a circulation that the increment of temperature of the water is only four degrees in a six-foot diameter boiler, we shall probably avoid steam formation on the plates to any serious extent, and get all our steam evolved on the upward passage. This would be an excellent thing for the shell bottom over the fire.

In Lancashire and Cornish boilers, the fire-heated surfaces are so near the top surface of the water that the above action cannot take place. It is curiously overlooked, and in so-called high-class marine boilers thickly clustered tubes are placed directly above furnaces, and must lead to some very curious results in the way of impeded circulation and priming. It is probable that, by enclosing the two sets of tubes by a sheet-iron lower box, such box or trough would be found to fill with soft mud easily blown out. If so found to act, it would be valuable in externally fired boilers, as a protection to the boiler shell against over-heating by sediment. The action of such trough coverings is, of course, the shutting off of a portion of the boiler, and the formation of a quiet zone for deposit of mud, which, not falling upon a heated surface, cannot bake hard, but remains a mud until blown away when collected in sufficient quantity.

When in America I was specially struck with the ease and rapidity with which tubular boilers could be turned out as compared with the standard Lancashire boilers of England, which demand so much more special care in the manufacture of the furnace tubes exactly to length of inside shell, and the special care needed to obtain true circularity as a safeguard against collapse.

Would Mr. Robb explain what he would have in a certified fireman? Is there not a danger in carrying the system of certification too far? If all firemen had to be certified as to their qualifications on the same lines as are followed in many other examinations, there is every probability that a good half of the best firemen would soon be found engaged on overtime by the boiler makers, who would be choked with orders for new boilers to replace those which left on their own account soon after the certified man had taken hold. If certification is to be compulsory, it should be conducted with great discrimination, for there are many excellent firemen who know their way about, and never ran

short of steam or water, who would be completely floored on a written examination, and yet who might show they had necessary knowledge at a *viva voce* examination.

For public safety, a periodical inspection by an engineer, coupled with attendance by an honest, conscientious fireman, who can throw on coal right way up, and test a safety valve twice a day, and has common sense, is all that is necessary.

What strikes me as peculiar in American practice is the enormous difference between the ordinary externally fired boiler, and such structures as are occasionally employed.

As I write I have before me drawings of a 90-inch locomotive type boiler for the Calumet and Hecla mines. This boiler for 185-pound gauge pressure has a maximum barrel diameter of 94½ inches. There are two flat-sided fire-boxes with separating water midfeather, and one flat-topped combustion chamber; 201 smoke tubes, more stud stays than I care to count, and a number of longitudinal bar stays, sling stays, etc., too numerous to detail. Such a boiler must be enormously costly as compared with even the Lancashire boiler, and probably less efficient economically.

This boiler measures over all when set 34⅛′x11⅛′x9½′, and is said to give 700 I. H. P. with a compound engine.

A 30 foot by 8 foot Lancashire boiler, which when set would measure 33⅓ feet by 10 feet by 12 feet would give 500 I. H. P. with a compound engine, and probably cost less than half the Belpaire boiler, and be far less costly in repairs. The use of flat stayed surfaces for high-pressure boilers seems so contrary to all American practice, and the whole boiler so far removed from the ordinary American type, that one is compelled to wonder why, and at a mine too, so extraordinary a construction should be adopted.

The use of such a boiler on a locomotive is not so much choice as necessity; but in stationary work such complication seems strange, especially when even the Lancashire and Cornish boilers, though so efficient, are considered as needlessly expensive as compared with the American boiler.

However, when Mr. Robb says the locomotive type is "almost impracticable for stationary purposes, especially in large sizes," perhaps he is unaware that there are in service or ordered over forty such boilers of nearly 8 feet barrel diameter at the Calumet and Hecla mines. W. H. BOOTH.

Force, Motion and Work.

BY PEDRO.

ELEVENTH PAPER.

FORCES ARE MEASURED BY EFFECTS.

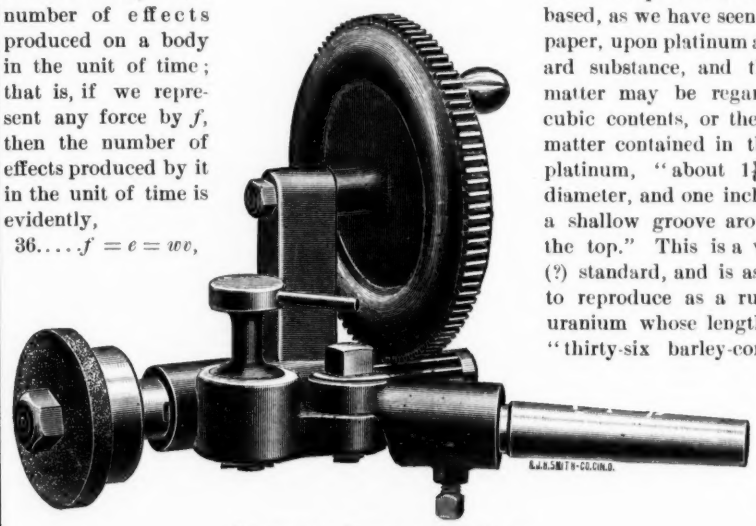
When we see a body moving we are not satisfied by simply knowing its speed, time of motion and space passed over. We also want to know how such a motion can be produced. We have seen that static force is the cause of motion, but how much static force is required to produce a given motion in a given body? We know nothing of the physical properties of force or of its origin, hence we know of no way of measuring it directly. We can only measure the effect produced by it. An effect is produced, for instance, when one body is moved from one place to another; but how large a body and how far will naturally be asked. It is evident that if two bodies are moved the same distance, one being twice as large as the other we would say that the effect produced in the larger body was twice as large as that of the smaller one. Again, if both bodies are of the same size, and one is moved twice as far as the other, we would say that the one moved the longer distance shows double the effect of the other one. Therefore the effect produced is proportional, both to the size of the body, and also to the distance moved. But still we are not satisfied; for we say that it requires more effort to move a cubic foot of iron than it does to move a cubic foot of wood. Why? Because the wood is lighter than the iron; that is, the cubic foot of wood contains less matter than the cubic foot of iron. This is true of all substances—all containing more or less matter to the cubic foot—hence, to compare effects produced in moving bodies, we must assume some substance as the *standard substance* with which all other substances are compared. We must also take a definite quantity of that substance; suppose it is a cubic foot, and as an example take iron for the substance. Now, the cubic foot of iron contains a certain amount of matter, and this would, then, be our *standard measure of matter*, or the unit of mass, and this unit of matter or cubic foot of iron, moved over a space of one foot would constitute the unit of effect, provided it was perfectly free to move without friction. If two units of matter are moved one foot, we get two effects; also if one unit of matter is moved two feet, we get two effects. Again, if two units of matter are moved two feet, we get four units of effect, because, if each unit of matter was taken separately, and moved one foot at a time, it would require four operations to move the two units of matter two feet, or the effort required to move one unit of matter one foot would have to be applied four times. It is evident, then, that the number of effects produced in moving any body is obtained by multiplying the number of units of matter by the number of units of space passed over. Hence, if we represent the number of effects by e, the number of units of the standard mass by w, the space by s, the average velocity of the body by v, and the time of motion by t, then,

$$35 \ldots\ldots e = ws = wvt.$$

Now, what is called "force" (or the measure of force) is the number of effects produced on a body in the unit of time; that is, if we represent any force by f, then the number of effects produced by it in the unit of time is evidently,

$$36 \ldots\ldots f = e = wv,$$

since v is the space passed over in the unit of time.



IMPROVED CENTER GRINDER.

If the motion is variable, then the space passed over in the unit of time is $\frac{1}{2}a$ (one, half of the acceleration, this being the average velocity), as we have seen in the fourth paper, in which case we have,

$$37 \ldots\ldots\ldots f = \frac{wa}{2}.$$

Equations 36 and 37 represent what we call *absolute force*.

If we make $v = 1'$ in equation 36, or $a = 2'$ in equation 37, then we get,

$$38 \ldots\ldots\ldots f = e = w.$$

Here we see that if any body is moving with an average velocity of one foot a minute, then the number of units of matter in the body is the same as the number of units of effect produced, and it is also equal to the number of units of force which produced the motion. This we call the *static force* (in absolute measure).

If we represent the force of gravity by G, and its acceleration by g, as before, we have by equations 37 and 38,

$$39 \ldots\ldots\ldots G = \frac{wg}{2} = \frac{fg}{2}.$$

If, now, $\frac{1}{2}g$ is taken as the *unit space* for measuring force, then,

$$40 \ldots\ldots\ldots G = w.$$

This is the static force of gravity, and the unit is called the pound, because the force is the same as the weight or quantity of matter in the moving body, and this is the force which has been generally adopted as the standard with which all other forces are compared. It is called *common* or *gravity* force, to distinguish it from absolute force.

If we should now adopt the cubic foot of iron as the unit of matter, then the number of cubic feet in any iron body would be the measure of the force which produced an average velocity in it of one foot a minute, if measured in absolute units. In this case we would have a systematic measure of force, since the unit (the cubic foot of iron) is based upon the standard unit of length in such a manner as to make it convenient to reproduce or originate a standard measure at any time from the linear standard and the standard substance.

The cubic foot of iron, however, would be too large for the unit of weight to be convenient. The physical properties of iron are also not so homogeneous, and therefore it is not so well adapted for a standard as some other substances. Pure water at a temperature of 62° F. is a very good substance, as it is always available, and practically unvarying in its physical qualities. Water is used as the standard substance in a number of measures, such as specific gravity, specific heat, etc. In the French system of measures it is used as the standard substance for the measure of force and weight. By adopting water as the standard substance we could establish a convenient systematic measure of force by adopting for the unit of mass a cube whose sides would measure one-quarter of a foot, or three inches—27 cubic inches.

This unit (.973766 of a pound avoirdupois) would be very nearly the same as the pound in common use.

The standard unit of weight in common use—the pound avoirdupois—is based, as we have seen in the tenth paper, upon platinum as the standard substance, and the unit of matter may be regarded as the cubic contents, or the amount of matter contained in that piece of platinum, "about 1⅛ inches in diameter, and one inch high, with a shallow groove around it near the top." This is a very definite (?) standard, and is as convenient to reproduce as a rule made of uranium whose length should be "thirty-six barley-corns, round and dry, placed end to end."

Every standard measure should, as far as possible, possess the quality of being conveniently replaced in case it should be lost. All efforts in this direction seem to have failed thus far. The claim that the meter is one ten-millionth part of a quadrant of the earth is visionary in effect, and has no practical value. The length of the second's pendulum as a basis of a standard measure seems the most plausible, but has proved a failure in an attempt to replace the English yard after being destroyed by fire in 1834. To have a permanent standard of length is of the greatest importance, since all other standard measures are based upon it either directly or indirectly. But it is not the purpose of these papers to discuss "standards" any further than they relate to the measurement of force, hence we will pass by this point.

Adopting, for the unit of matter, the piece of platinum previously referred to, and gravity as the standard force (equation 40) of comparison, we see what an unsystematic method we have for measuring force. In the first place the unit of mass is the awkward measure of about $\frac{1}{1842}$ part of a cubic foot of platinum. In the second place, to get a measure of the common unit force, we see by equations 39 and 40 that we must take a space of $\frac{1}{2}g$ for the unit of space instead of the foot.

Now, take any two bodies whose masses are w_1 and w_2, and suppose that they are set in motion by the respective forces f_1 and f_2, then we have by equation 37,

$$f_1 = \frac{w_1 a_1}{2} \text{ and } f_2 = \frac{w_2 a_2}{2}.$$

Dividing the first of these equations by the second we get,

$$41 \ldots\ldots\ldots \frac{f_1}{f_2} = \frac{w_1 a_1}{w_2 a_2}.$$

That is, *the forces required to impart motion to material bodies are proportional to the product of the masses or weights of the bodies, and the acceleration imparted to those bodies.*

When the weights of the two bodies are equal to each other, then

$$42 \ldots\ldots\ldots \frac{f_1}{f_2} = \frac{a_1}{a_2}.$$

Or, for the same body, forces are proportional to the acceleration imparted to it.

This is what is usually stated in the second law of motion.

Taking for one force that of gravity, G, then we get from equation 42,

$$\frac{f}{G} = \frac{a}{g}.$$

Substituting the value of G from equation 40, we get,

$$43 \ldots\ldots f = \frac{G\,a}{g} = \frac{w\,a}{g}.$$

Rule 43.—To find the force which is required to set any body in motion with a given acceleration, *multiply the weight of the body by the given acceleration, and divide by the acceleration of gravity.*

Example.—Suppose a train of cars to weigh 270,000 lbs., how much must the engine pull—supposing the pull to be constant, and that there is no friction—to start the train with an acceleration of 2,500 feet a minute? From rule 43 we have,

$$f = \frac{270{,}000 \times 2{,}500}{115{,}776.} = 5{,}830. \text{ lbs.}$$

Improved Center Grinder.

On this page we give an illustration of a center grinder, which, instead of being held in the tool-post, is fitted to a shank which is tapered to fit the foot-stock spindle, so that to true the center it is only necessary to remove the dead center, and insert the shank of the grinder in its place.

The traversing motion of the wheel is obtained by a rack and pinion movement, while the wheel is driven by means of the large gear wheel turned by hand, a small pinion on the spindle giving the necessary speed. Any angle from 40° to 60° can be obtained, and, as will be seen, it is a matter of only a few minutes' work any time to secure centers absolutely true and to standard gauge. When once set to grind accurately to gauge, no further setting is required to insure that all centers shall be correct.

The makers are Wm. Barker & Co., Cincinnati, Ohio.

The world is fast losing its deserts. There was a day when the United States had one of no small size, when it was claimed that all the land west of the Missouri River was a barren waste. The farmers of Kansas, Nebraska and Dakota have disposed of much of the great American desert. Once upon a time large portions of the interior of Africa were believed to be arid and uncultivable. Now we learn that they are fruitful and well populated. The interior of Australia has been held up as an awful example of a howling wilderness, destitute of water and of animal or vegetable life. That illusion is now being rapidly dispelled. Recent explorers report that inner Australia is no Sahara waste, and that, though uninhabited, it can support a large population. There are grassy plains, and also traces of gold and precious stones. A north-and-south railway is now building through the center of Australia, and doubtless, with its completion, the last trace of the desert will vanish. The iron horse is a wonderful dispeller of illusions of that kind. The truth is that there are vast regions on this continent, in Asia and Australia, which are barren from the standpoint of primitive and ignorant agriculture, but which, when taken in hand by the educated farmer of to-day, with his modern implements, blossom like the rose. —*Invention.*

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CONTENTS.

	PAGE.
Double Pitman Blanking Press	1
Boiler Head Flanging Machine	1-2
Stress in Structures	2-3
Reversing Gear for Small Yacht Engines	3
Tall Chimneys	3
Simple as A B C	3
The Largest Traveling Crane	5
An Improved Bench Drill	5
Letters from Practical Men: Dipping Brass. By A. E. Dupas—Preserve the Eyes. By Gage Tool Co.—Water Lines. By M. P. Janney—Grinding Lathe Tools. By Walter Gribben—A Question in Ethics—Lifting Water Forty Feet. By Fred H. Colvin—Internally and Externally Fired Boilers. By W. H. Booth	6-7
Force, Motion and Work. By Pedro	7
Improved Center Grinder	7
An Effect of War	8
Not Recognized	8
Personal	8
Questions and Answers	8, 9
Manufactures	9, 10
The Mechanical Engineers	10-11
Chicago's Third Fire-boat "Yosemite"	11-12
Progress in Heating Cars by Steam	12
About Measurements	12
Spring Birds Build Homes in Electric Light Globes	12-13
Machinists' Supplies and Iron	13

An Effect of War.

From the earliest times of which we have any record, down to the present day, war has been one of the greatest causes of the development of mechanical and engineering skill. The savage, though he may show considerable skill and ingenuity in the adaptation of means to ends so far as the production of his rude clothing, his tents or huts, and culinary utensils are concerned, always exhibits his highest skill and his most careful workmanship upon his implements of warfare. He knows that upon the excellence of his weapons will depend, in large measure, at some time or other, his existence and that of his family, and he spares no pains or labor in the selection of the materials for, nor in the construction of his spear, his bow, his boomerang, or his war-club.

With the development of the art of metal working, the best skill has from the first been devoted to the production of the best shield, armor, lance, sword, shoulder gun, or cannon. And what has been true in the past is just as true to-day.

Every nation requires that its arms and everything supplied for use in war shall be the very best that skill and ingenuity can provide, and by a rigid system of inspection sees to it that the very highest standard of workmanship is maintained.

It is well understood that the appearance of the map of Europe after the next war, which at times seems imminent, will depend greatly upon the relative efficiency of the guns carried by the troops of the various armies. The perfect or imperfect working of breech mechanisms, the good or bad temper of bayonets or sabers, the accurate or inaccurate rifling of cannons, will largely determine what nations shall be wiped out of existence, and to whom their territory shall be alloted; hence, no pains nor expense are considered too great to be borne in securing the very best materials and construction that it is possible to produce.

It is difficult to form an accurate idea of the effect of this competitive struggle for the highest excellence upon the development of mechanical and engineering skill; but that its effect is very great, no one at all familiar with such things, and who considers the matter at all, can for a moment doubt.

The work which has been turned out from the armories of our own country has done much, probably more than that done in any other one class of shops here, to develop the high skill of the tool-maker for which we are famous, and in which we undoubtedly lead the world; and on the other hand there can be little doubt but that the modern development of heavy ordnance, armor-plates, and naval vessels, that has been going on for years in England and on the Continent, has had much to do with giving European nations the advantage of us in the heavier classes of work, whether pertaining directly to warfare or to more peaceful pursuits. We may form some idea of how great this influence has probably been, by observing the effect upon our own tool-building and engineering establishments of the recent revival of interest in the subject of armament here. That it has resulted in some very decided advances in engineering within the past three years is very apparent; tools and other machinery of the very heaviest and best class having been constructed within that time, for which it seems unlikely there would have been any demand whatever, for years to come, for any other purpose. The traveling crane, illustrations of which appear in this issue, is a case in point. It is, so far as we know, the largest and heaviest crane of its type ever built in this or any other country, and its construction was called for by the necessity of providing some means of expeditiously handling the heavy guns which are to be made here.

The use of such a crane, and of the heavy tools which the Navy Department is putting in, has the effect, directly and indirectly, of bringing about the use of similar machinery in private industries; thus, in the end, benefiting the peaceful arts, and when this influence shall have been exerted here through as many years as it has been acting in European countries, we venture to predict that we shall not be found very far behind those countries in our facilities for handling the heaviest work.

This is not put forward as a justification or excuse for war, and we are not discussing the question of the net advantage to humanity of carrying on wars; we merely call attention to an observed and very interesting fact; *viz.*, that wars and preparations for war have from the first, and still have, a greater influence than any other single occupation of the man animal in developing the highest mechanical and engineering skill.

Not Recognized.

According to one of the census enumerators the profession of mechanical engineering is not to be recognized in the eleventh census. He called the other day at the house of a well-known engineer connected with a prominent tool building establishment, and, in accordance with the schedule, inquired what was the occupation of the head of the family. On being informed that he was a mechanical engineer, he objected that that was no profession, and wouldn't be recognized as such by the government. The lady insisted that her husband was a mechanical engineer, and that she knew of no other name for his business, but in order to satisfy the man told him that he designed machinery, made the calculations pertaining to it, and had charge of the drafting room. Then a great light seemed to break in upon the representative of the United States Government, and with the air of having finally gotten something intelligible where an intelligent answer was hardly to be expected, he put down our friend's occupation as draftsman, which, he said, would be accepted by the authorities, and recognized as an occupation.

The final result to the leading engineers, of the great French copper syndicate, cannot fail to be gratifying to all who believe in open and free competition in trade. They have not only lost vast sums of money, but are now further afflicted by heavy fines and terms of imprisonment. Fines are not usually very burdensome to such men, but prison life is especially so, and there are many people in this country who would be in favor of like punishment for some of our so-called "American financiers," whose methods consist chiefly in underhanded operations designed to cripple competitors and force them out of the market. The number of people who think thus, besides being great at present, is, we believe, constantly increasing, and it may be that some day there will be a sufficient number of them to secure legislation in that direction.

Personal.

Mr. Joseph P. Mullin has resigned his position as draftsman in the Beckett Foundry & Machine Works, at Arlington, N. J., to take the position of superintendent and general manager of the Jersey City Machine Works. *The Kearney Record* gives Mr. Mullin a flattering notice.

Whatever else we may be deprived of doing by the operation of trusts, if the *Sun* is correct we shall be allowed to smoke. It appears that the firm of Straiton & Storm, cigar manufacturers, refused to go into a cigar trust, which English capitalists were trying to organize, and, instead, turned the firm into a company, of which employes own about $100,000, and customers $200,000. Having put itself in fighting trim, the new company expresses itself ready to try conclusions with any cigar trust or combination that may be formed.

Young mechanics make a very egregious mistake when they begin to think that they do too much for their employers when they work a few moments overtime to complete a small task they are performing just at the time the whistle blows to quit work. More young men have been kept from receiving an advance in their wages from this than from any other known cause.

The foregoing is from the *Builders' Gazette*. In our opinion there is a good deal of popular nonsense in it. When a mechanic, young or old, is expected to be at his post at the tap of the bell in the morning, and to work faithfully through the day, it is his right to quit promptly at night. He is not allowed to quit fifteen minutes earlier without losing the time, and should not be expected to give fifteen minutes of his own time without remuneration. In our opinion, "young mechanics," when they work the full hours for which they are paid, are doing all that ought to be expected of them.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(231) W. H. T., Galt, asks: Can you inform me where, and at what cost, I can obtain a book that will give me information on the universal milling machine? *A.*—The only book we know of that treats of this subject is published by the Brown & Sharpe Mfg. Co., at a price of $1.60.

(232) E. G. S., ——, writes: Please inform me if two bevel gears of 36 teeth, and about two inches diameter, and one with 12 teeth of the same pitch could be used in transmitting small power from a horizontal to a vertical shaft, the small gear to run from 100 to 125 revolutions? *A.*—It could be done by such an arrangement, though the amount of power transmitted would be very small. It would be better, however, if it could be arranged to give the pinion more teeth; say not less than 16.

(233) J. J. J., Middletown, N. Y., writes: I would like to know the amount of lap and travel of valve to cut off at half stroke. The stroke of piston is 10 inches, steam port, $1\frac{1}{16}$ inch wide; exhaust port, $1\frac{3}{8}$ inches wide; bridges as narrow as $\frac{3}{8}$ inch. Can I make the bridges as narrow as this? If not, how wide will they have to be? The exhaust port cannot be changed. *A.*—If the width of port has been properly designed, so that it will have to be opened fully, the travel of the valve will have to be 5 inches, lap, $1\frac{3}{8}$ inches. There is no objection to make the bridge $\frac{3}{8}$ inch wide, but if we understand you to say that the exhaust port cannot be changed with bridges $\frac{3}{8}$ inch wide, then you cannot cut off at half stroke, as the valve will cover the exhaust port completely.

(234) J. B. P., Cambridgeport, Mass., writes: Please let me know the number and size of boilers on the flagship Chicago. *A.*—There are three double-ended and six single-ended steel boilers. They are set in brick and fired externally. Length of double-ended boilers from outside to outside of tube sheet, 24 feet 8 inches; length of single-ended boilers, 11 feet 10 inches; diameter of each boiler, 9 feet. Number of tubes in each boiler, 192; outside diameter, $3\frac{1}{4}$ inches; length, 8 feet $10\frac{1}{2}$ inches. Length of grate, 7 feet; width, 8 feet. Total grate surface, 672 square feet; total heating surface, 19,950 square feet; total area of superheating surface, 1,356 square feet. Ratio of grate surface to total heating surface, about 1 to 30. Ratio of calorimeter through tubes to grate surface, 6 to 1. Capacity of total steam room in boilers, drums, pipes and high-pressure steam chest, 3,282 cubic feet.

(235) T. J. Mc., Philadelphia, Pa., writes: To settle a disputed point, please say which is the best method of calculating the rise of a segment of a circle whose area is $\frac{2,157}{6,157}$ of the area of the circle. Diameter of circle, 78 inches. Would prefer the solution in plain figures. *A.*—Reduce the fraction to a decimal, which is equal to 0.35. Multiply the area of the circle, which is 4,778.36 square inches, by 0.35; the product will be the area in square inches of the segment, and is equal to 1,672.426 square inches. Divide this area by the square of the diameter,

$$\frac{1,672.426}{78 \times 78} = .274;$$

look for this quotient in a table of areas of circular segments in the column marked areas, and opposite to it you will find the decimal .381; multiply this decimal by the diameter of the circle, $.381 \times 78 = 29.71$, which is the height of the segment in inches. You will find a table of areas of circular segments in Trautwine's Engineers' Pocket-book.

(236) C. A. T., Jackson, Mich., writes: We have an electric motor running a small shop, and wish to find out about how much

power we are using, by some simple method. Can you suggest anything? About how much power, on an average, do you think it would take to run an 18-inch lathe ten hours a day, a 24 inch by 6 foot planer about three hours a day, and a 20-inch drill press two hours a day? I realize that if forced to do all that could be done on them, it would take many times the power that ordinary practice on light work requires. Everything runs nice and easy, the machines are new and of late design, the friction which operates the feed of the planer is released after the work is done. *A.*—There is an instrument by which the current supplied to the motor can be measured, and its equivalent in horse-power determined, but the best way is to apply a dynamometer. We think it would require somewhat less than a horse-power when all three machines are running, and probably about one-half a horse-power for the lathe. This is assuming that there is a line-shaft which has to be driven whether all or only part of the tools are in use.

(237) N. C., Bay City, Mich., writes: We have in a wood-working machine two feed rolls—upper and lower—5⅞ inches between centers, power transmitted from the lower to the upper by a pair of gears. We now wish the centers to expand from 5⅞ to 6¼ inches (to take in ¾ or 1½-inch lumber) during the working of the machine. Is it possible to make gear that will work accurately and give the desired result? The gear we now use will allow centers to expand ¼ inch, and works satisfactorily. At the present writing I have failed to get what we want without too great sliding motion, which is not practicable. If it is possible to obtain the result desired, will you kindly give me the pitch and form of teeth required? *A.*—We do not think that gears of the size you memtion can be made to work satisfactorily at such variations of center distance. Where so much motion is required it is customary to provide for it by means of what is called an expansion train, which consists merely of two intermediate gears linked together, and to the shafts on which the main gears are mounted. This arrangement you have probably seen in use, but if not, it is to be seen on many planing machines.

(238) H. S. T., Corinth, Miss., sends us two sketches of cast-iron piston rings; both rings are 10 inches outside diameter. The thickness of ring marked No. 1 varies, the thinnest part being $\frac{3}{16}$, and the thickest $\frac{5}{16}$ inch. The ring No. 2 is bored out concentric, its thickness being $\frac{5}{16}$ inch all around. In regard to these rings our correspondent says: The disputed point is this: If we should cut two inches out of each ring, that is, cut No. 1 ring in the thinnest part, and cut No. 2 at any place (as it is the same thickness), the question is which ring will require the greater pressure to bring the ends together, the pressure being applied at the ends? Some of my shopmates claim that the ring with the thin side will require the most pressure; but I differ with them, and if I am wrong I want to know it. *A.*—According to the dimensions on your sketch the inside diameter of No. 1 ring will be $10 - (\frac{5}{16} + \frac{3}{16}) = 9\frac{1}{2}$ inches; the inside diameter of No. 2 ring will be $10 - (\frac{5}{16} + \frac{5}{16}) = 9\frac{3}{8}$ inches; hence, since the inner diameter of No. 1 ring is greater than that of No. 2, the former will require less pressure to bring the ends together than the latter. If the inner diameters are equal it is difficult to say which will require the greater pressure to bring the ends together, and believe that this point can only be decided by actual experiments.

(239) H. G., Baltimore, Md., writes: I want to use pure carbon in some experiments. If I go to a chemist for it what should I ask for, and in what state will I receive it? *A.*—Ask for carbon, and state the purpose for which it is to be used. Carbon is a solid substance, destitute of taste and odor, but it occurs in several modifications, which exhibit very diverse physical properties. 2. If I had a tank containing some water, into which I place a pump through the top of the tank, and extract all the air possible from the surface of the water with an air pump, will I be able to pump water with the first-named pump from the tank? *A.*—If the first-named pump is a suction pump you will not be able to take any water out of the tank. With a suitable lifting pump you will be able to do so. 3. For finding the strain on a cylindrical part of a boiler one authority says: "Multiply the diameter in inches by the length in inches, and the product by the steam pressure per square inch." Another authority says: "Multiply the circumference in inches by the length in inches, and multiply that product by the steam pressure per square inch." Which is correct? I think the last one is correct. *A.*—The first one is correct. For practical boiler construction it is necessary to know the stress per square inch of iron; to find this stress use the following rule: Multiply the inner radius in inches by the steam pressure per square inch, and divide the product by the thickness in inches; the quotient will be the stress per square inch of metal.

(240) C. D., ——, asks: What is the proper amount of taper to allow in turning mandrels two feet long, which are to be used in turning pulleys and that class of work, the hubs ranging from 3 to 6 inches in length, and three inches in diameter? What ought the taper to be to the foot, and can you give me any general rule for the taper of mandrels? *A.*—For such arbors we should give a taper of .005 inch to the foot, or .01 for the whole arbor. We do not think that a general rule for the taper of arbors is practicable. Where the work is of the best and finest quality, and kept very close to standard size, we think it is best to make the arbors of uniform size, or very nearly so, for about three-fourths of their length, and then taper them to the end. For other kinds of work we should adopt the plan recommended above, the amount of taper depending upon the character of the work, and the closeness with which it was proposed to keep to standard sizes. 2. What size hole should I bore in the stuffing-box of an ordinary fast-running engine with rod 2 inches diameter, in order to insure a good steam-tight fit without cramping rod, or producing any unnecessary friction? *A.*—You cannot get a steam-tight fit in this way without the use of packing, unless you adopt some such plan as is used by Prof. Sweet in his Straight Line engine, which is a very long bush of soft metal, which the rod passes through. Where ordinary packing is to be used the hole should be 1-32 inch larger than the rod, though if it is desired to have it as close as possible, and pains are taken to do accurate work, it may be somewhat closer than this.

(241) J. M., Jeffersonville, Ind., writes: In your answer to Question 478, Dec. 26, 1889, you say that you prefer not to use mud drums, that they are dangerous adjuncts, and liable to corrode. How are they more liable to corrode than other parts of the boiler? It seems to me they are all right, and just the thing for receiving mud and scale. Now, we are going to put in three 40x24-feet boilers, and would like to know if you would discard the mud drum. *A.*—We referred to mud drums whose axes are perpendicular to the axes of the boilers. In order to make these drums of any use they have to be made of a comparatively large diameter, and the corresponding holes which have to be cut into the shell of the boiler weaken the boiler; the consequence is that the joint of drum to boiler soon begins to leak, and since these drums are placed where they cannot be readily seen, the leak may continue for some time before it is noticed, and corrosion ensue. Drums of this kind are often subjected to a great heat, and the access to them is difficult. The consequence is that they are often neglected, allowed to remain filled with mud, and thus become dangerous. We should strongly advise you not to use this kind of mud drum. The horizontal mud drums placed crossways to the boiler, and extending from outside to outside of brickwork, and attached to the boiler by a nozzle of comparatively small diameter, are preferable, and if judiciously placed, with proper hand-holes at the ends, answer their purpose well. If you are not acquainted with the construction of boilers and boiler settings, we should advise you to put the work in the hands of a competent mechanical engineer; it will save money and trouble in the end. 2. Is $\frac{3}{16}$ of an inch lead too much for a 14x36-inch slide valve engine, speed about 95 revolutions per minute? *A.*—It is too much; probably $\frac{1}{16}$ or a little less will be quite sufficient.

(242) H. G. B., Washington, D. C., writes: Please inform me how fast a piston will travel in an 8x8 inch cylinder, by the pressure of the atmosphere with a vacuum on the opposite side of the piston, barring friction. *A.*—The speed of piston will depend on the weight of piston, crosshead, etc., attached to it. For the sake of illustration we shall assume that the cylinder is horizontal, and the total weight to be moved is 16.1 pounds. Our first step will be to find the acceleration per second, for which we use the following formula:

$$a = \frac{f}{m},$$

in which a denotes the acceleration per second, f the force which moves the piston, and m the mass of the body, which is equal to the weight of the body divided by 32.2; hence we have for the mass

$$\frac{16.1}{32.2} = .5.$$

Taking the atmospheric pressure at 15 pounds per square inch, the total force which moves the body will be equal to the area of the piston in square inches multiplied by 15, which is $50.27 \times 15 = 754.05$ pounds. Now substituting the values for the symbols in our formula, we have

$$a = \frac{754.05}{.5} = 1{,}508,$$

which is the acceleration in feet per second; that is to say, every second the velocity will increase 1,508 feet. To find the velocity at the end of the stroke we employ the following formula:

$$v^2 = 2\,a\,s,$$

in which v is the velocity in feet per second at the end of the stroke, a the acceleration as before, and s the stroke in feet. Substituting the values for the symbols in the last formula, we have

$$v^2 = 2 \times 1{,}508 \times .66;$$

hence $v^2 = 1{,}990.56$, and $v = \sqrt{1{,}990.56} = 44.6$ feet per second; that is to say, at the instant that the piston has reached the end of stroke of 8 inches its velocity will be 44.6 feet per second. Its average velocity will be 22.3 feet per second.

(243) T. W. H., Newchurch, England, writes: We have in our shop a Cornish boiler, 12x5 feet, with two 8-inch flues without cross tubes of any kind. The boiler has to supply steam for a 6x12 inch engine, which is in first-class order, and occasionally steam has to be furnished to two small steam hammers, cylinders 6x9 inches. We are burning from ten to twelve tons of coal a month, which I think is excessive. We can drive a full speed at anywhere from 45 to 65 pounds boiler pressure, to which the boiler is insured. The man who has charge of the boiler has other duties to attend to, and the boiler is apt to get neglected. Sometimes the steam and fire will get low, and the fireman will shovel on a great heap of coal, then draw the dampers full open, and then leave the boiler for about thirty minutes; all this time a large amount of heat is rushing up the chimney. I propose to retain this heat in the following manner, and I will be pleased if you will pass your opinion upon it: I intend to place a small exhaust fan, and connect it by means of pipes to the back end of boiler, and the delivery from the fan I intend to lead to the underside of grate bars; the amount of blast is to be regulated as required. I think with this arrangement quite an advantage will be gained if it will work. Please say if this system will be preferable to the smithy fan, which we now use for the forced draught. *A.*—We believe that your arrangement will not work; it may seriously interfere with the draught of the chimney, and it will not supply the furnace with a sufficient quantity of pure air required for combustion. It seems to us that if the grate and chimney are properly proportioned the boiler should be able to supply enough of steam for the small amount of work required without any forced draught. Another great mistake is to require the fireman to attend to other duties which take his attention off the boiler. More coal can be saved from judicious and careful firing than by any other means. If you desire to reduce your coal bills, employ a first-class fireman, and let him devote his whole time to the boiler, and you will be the gainer in every respect in the end.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Lexington Cut Iron Gears. See adv. on p. 20.
Link-Belting and Sprocket Wheels.
Send for Catalogue of Link-Belting.
Over 50,000,000 feet of Link-Belt in use.
Link-Belt Engineering Co., Philadelphia and N.Y.
Shafting Straighteners. J. H. Wells, Tampa, Fla.
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"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.
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Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.
Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.
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Standard Tool Co.'s Twist Drills. S. A. Smith, 23 S. Canal st., Chicago, Western Representative.
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Steel Name Stamps, etc. Address W. G. Sackmann, 1099 First ave., Cleveland, O.
Get particulars of our new Wall, Suspended and Radial Drills. C. H. Baush & Sons, Holyoke, Mass.
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Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

For best Return Steam Traps, Pressure Regulators Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N.Y. Send for des'n

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See June 5, p. 18. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Brown & Sharpe Mfg. Co's. standard spur and bevel gears carried in stock by Chandler & Farquhar, agents, 177 & 179 Washington st., Boston, Mass.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

Patent Attorney. R. G. DuBois, 715 11th st., Washington, D. C., procures first-class patents on inventions. Valuable Hand-book on patents free.

Horton's Chucks. We offer the balance of our stock at 50 per cent. discount. McFadden Co., Philadelphia, Pa.

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For Sale—Bound volumes of the Patent Office Gazette for years 1883, 1884, 1885, 1886, 1887 and 1888. Price, $4 per year. Address J. C., care of AMERICAN MACHINIST.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations, 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

Montgomery & Co., 105 Fulton st., New York City, have just issued a small catalogue of 160 pages, containing description and prices of many useful tools. A copy will be sent free to any address upon application.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting Rods for small connections. Especially adapted for Valve Rod for Steam Engines.
T. C. Dill Machine Co., Philadelphia, Pa.

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Just concluded. "Modern Locomotive Construction." By J. G. A. Meyer. The above series of 106 articles, which have attracted so much attention everywhere, is now concluded in newspaper form. Copies of the American Machinist containing the entire set sent by mail to any address in the U. S., Canada or Mexico for $5.30, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

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MANUFACTURES

A 500,000-dollar stock company is being organized to build car works at Macon, Ga.

The Alabama Sheet Metal Company is being formed, to be located at Greenville, Ala.

The Exeter Machine Works, Exeter, N. H., propose quite an extensive addition to its plant.

A woolen mill, with a capital stock of $50,000, and a rolling mill, are projected at Graham, Va.

S. K. White, 74 to 88 Market street, Chicago, is about to put up a large machine shop and foundry.

The Pratt & Whitney Co., Hartford, Conn., are employing 825 men, and 40 are on all-night work.

The Chicago (Ill.) Rawhide Mfg. Co. are filling orders for belting from England, Russia and Germany.

The Jennings & Griffin Manufacturing Company, of Yalesvile, Ct., are to build an addition to their factory.

The A. Campbell & Co. woolen mills, at Manayunk, Pa., employing 250 hands, have closed until September.

A two-acre lot on Maury street, Manchester, Va., has been given the Johnson Axle Co., of Richmond, for a foundry.

J. Koons Saylor is starting a new mill for the manufacture of seamless hosiery at Quakertown, Bucks Co., Pa.

It is reported that the Roanoke (Va.) Iron Company contemplates increasing its capital stock to build a rolling mill.

A foundry and machine shops will be established at Florence, S. C., by the Carolina Real Estate and Investment Company.

A spoke and handle factory, 50x100 feet, will be erected at Bridgeport, Ala., by J. N. Zimmerman & Co., of Augusta, Mich.

The woolen mills at Byfield, Mass., have adopted ten hours for a day's work, which is also the rule in their Holliston branch.

The Kilby Manufacturing Company, Cleveland, Ohio, will build additions to its machine shop, 60 x 60 feet, and 50 x 100 feet.

The Cherokee Falls Manufacturing Co at Blacksburg, S. C., will enlarge its mill by erecting an L, three stories, 150x100 feet.

The Williamstown Manufacturing Company, of Williamstown, Mass., will add a lot of new spinning machinery to its mill.

A company to establish a yarn mill at Kershaw, S. C., is being organized by J. E. Pearce and others. The capital stock will be $50,000.

It is stated the Henderson Steel and Manufacturing Company, of Birmingham, Ala., is having plans prepared for the erection of another furnace.

The Bessemer Cornice Works, of Bessemer, Ala. have been incorporated, with a capital of $50,000, by W. J. Long, T. J. Cornwell, H. S. Long and others.

The Howe Scale Works at Rutland, Vt., which already cover ten acres, are to be materially enlarged, and improved machinery is to be added to the present plant.

The National Acid Company, New Orleans, La., has been incorporated, with a capital stock of $150,000. The company will build a 100,000-dollar factory at once.

The American Wheel Co., to manufacture tricycles, has been organized at Chicago with $150,000 capital; incorporators: J. A. Steinberg, Charles Sueme, G. Freefield.

Plans are now being drawn for Bernard & Co's. new shoe factory to be erected at Danvers, Mass. A 100 horse-power boiler and a 75 horse-power engine will be required.

The Dupont Paper Mill, Louisville, Ky.. was recently totally destroyed by fire, ruining machinery and material valued at $250,000, the insurance on which is placed at $125,000.

The Berlin Iron Bridge Co., East Berlin, Conn., are very busy on some large orders, and are employing 250 men on inside work, and also about 250 men on their outside or erecting work.

B. I. Walshe and Timothy Maroney, of New Orleans, La., have incorporated the Attalla Iron Company, to build an iron furnace and rolling mill at Attalla, Ala. The capital stock is $400,000.

A. G. Moore, Charles Hoefinghoff, Thomas Clifton and others, are the corporators of the Gadsden Bar and steel Mill Company, recently incorporated at Gadsden, Ala., to build sheet-iron and rolling mills.

H. K. Porter & Co. have, at their works, nearly completed, two locomotives for use in coal mines in northern Mexico. The engines are 7"x12". They will run on a 3 foot gauge, and are fitted with a variable exhaust.

Six hundred thousand dollars has been subscribed to the capital stock of the $1.000,000 cotton factory at Huntsville, Ala. Most of the stock is being taken by Eastern capitalists, although the citizens are liberal subscribers.

The Wonder Sewing Machine Manufacturing Company has been incorporated at Chicago, to manufacture sewing machines. Capital stock, $500,000. Incorporators: W. M. Pettingill, Josiah Cratty, and W. W. Watson.

A company, with a capital stock of $10,000, will be organized in Gordon, Pa., for the purpose of establishing an electric light plant. Hon. D. D. Phillips, F. E. Dreher, George M. Hadesty and others are interested.

R. G. Maines, Edward Stauder and A. F. Briton, are the names of the incorporators of the Five-second Ice Cream Freezer Co., recently formed at Chicago, to manufacture an ice cream freezer. Capital stock, $10,000.

Laredo, Tex., has offered to donate five blocks to any party who will build a cotton mill to cost $100,000. Mr. J. L. McVicker, of New York, is reported to have accepted the city's offer, and the mill will soon be built.

The Pennsylvania Steel Company has awarded the contract for the construction of the necessary wharves at the new plant at Sparrow's Point, near Baltimore, Md., on one of which machine and coppersmith shops are to be built.

The Auburn (Me.) Stove Foundry Company has been organized with H. W. Hutchings as president, and J. R. Learned as treasurer. The capital is $50,000. The plant of the Biddeford Stove Company will be removed to Auburn.

Wolterstorff, Haskell & Co. have succeeded Wolterstorff, Moritz & Co., in St. Paul, Minn. The firm are makers of the commander wrought-steel ranges, as well of a general line of culinary implements and utensils for hotel cookingand restaurant purposes.

Scott's woolen mills at Saugus Centre, Mass., have shut down, throwing 100 hands out of work. The business, which was profitable, has been very dull for some time, owing to large blocks in wool products at New York, and the poor state of the market.

The Birmingham Safe and Lock Works, Birmingham, Ala., have been purchased for $90,000 by a stock company, and will be operated by them. The officers of the company are: J. C. Kyle, president; J. M. Thompson, vice-president; and B. A. Thompson, secretary.

The question of building more flouring mills in this city should receive more earnest consideration from our enterprising business men than has been given it. The mills we already have are running at full capacity night and day, and then cannot supply the demand.—*Times*, Leavenworth, Kan.

The Memphis Equipment Company, having a capital of $1,000,000, has been incorporated at Kansas City by Nathaniel Thayer, of Boston, George H. Nettleton, of Kansas City, Mo., and others, to build cars upon the car trust plan for the Kansas City, Fort Scott & Memphis and the Kansas City roads.

The Electric Wheel Company, Quincy, Ill., incorporated by Mr. S. H. Emery, Jr., Thos. Hill and C. G. Comstock, have contracted for a building, which is to be completed by July 1st., for the manufacture of metal wheels for all purposes. Especial attention will be given to wheels for farm implements.

In a note in these columns that appeared in our issue of June 5, relating to the works of the Middletown Machine Co., Middletown, Ohio, the omission of the letter w made their location Middleton. It should have been *Middletown*. The large dogs mentioned were furnished to the Erie Forge Company, of Erie, Pa.

A corporation, to be known as the Franco-American Can Opening Company of Maine, capital stock $50,000, has been organized at Portland, for the purpose of manufacturing and dealing in cans and appliances for opening the same. Charles P. Mattocks, of Portland, is president, and Frederick Jones, of Deering, treasurer.

A corporation, to be known as Jones Special Machine Company, has been organized at Portland, Me , for the purpose of manufacturing sewing and embroidery machines. The corporation has a capital stock of $100,000, and its officers are: President, J. Thomas Jones, of Utica, N Y., treasurer; Arthur G. Hosmer, of West Newton, Mass.

The syndicate which is to build a morocco factory at Danvers, Mass., for Bernard & Co., of New York, has chosen G. A. Tapley president, Francis Dodge vice-president, and W. F. Putnam secretary and treasurer. The building will be 175 by 40 feet, four stories above basement, and with pitch roof. The firm will employ about 250 hands.

A corporation, to be known as the Trip Giant Leveler Company, has been organized at Portland, Me., for the purpose of manufacturing machinery for shaping and leveling boots and shoes. The concern has a capital stock of $120.000, and its officers are: President, Charles A. Snow, of Boston, Mass.; treasurer, Edward P. Adams, of Cambridge, Mass.

Among recent Chicago corporations are: The Chicago Refined Metal Company, at Chicago, to manufacture and sell metals, capital stock $200,000, incorporators, H. P. Benton, J. S. Ward, Gordon McDowell; and the Chicago Heat Storage Company, to manufacture appliances for producing storage heat, capital stock $600,000, incorporators, C. G. Singer, F. W. Melick, and John Le Boutillier.

License of incorporation has been issued to the Builders' Mantel Company, at Chicago, to conduct a general mantel, grate and tile business, capital stock $12,000, incorporators, Henry G. Dawson, W. R. Dawson and John M. Dodd; and the Calorific Stove Company of Chicago, to manufacture and sell calorific and other stoves, capital stock $100,000, incorporators, G. Meyers, F. D. Holbrook and F. W. Holbrook.

A contract has been placed with the Shiffler Bridge Company, of Pittsburgh, Pa., by the American Wire Nail Company, of Covington, Ky., for the construction of an iron building to take the place of their rod mill at Anderson, Ind., destroyed by fire. Since the fire they have been operating under temporary buildings, but the new one, 262x 210 feet, is to be completed in sixty days.

Jones & Lamson Machine Co., Springfield, Vt., have issued a new and extremely neat catalogue of turret screw machines for general lathe work. The engraving and printing was done by A. G. Mugford, of Hartford, and is in his best style, the engravings being printed on tinted sheets. Attention is called to the fact that the machines shown are built for chucking and general lathe work of all kinds, as well as bolt, screw and stud work.

Contractor Mather, of Northampton, Mass., will resume work next week on the new mills of the Mt. Tom Sulphite Pulp Company, the agent having returned from Europe with new plans The mills will be much larger than was originally designed, and upward of 500,000 more brick will be required to finish the job. It is expected that the mills will be started up during the fall, if the special machinery which is to be constructed can be secured in time.

The old cotton mill at Jackson, R. I., that has been standing idle for sixty or seventy years, has been purchased by B. B. & R. Knight, of Providence, and is to be remodeled and newly equipped with cotton machinery. The plant was first owned and run by ex-governor Charles Jackson. It consists of a main building, with small addition in front, and a number of tenement houses Work of reconstruction will begin in a short time. As soon as this factory is remodeled the last old-time factory village of New England will disappear.—*Commercial Bulletin.*

At a recent meeting held in Memphis, Tenn., of the bondholders of the Sheffield & Birmingham Coal, Iron & Railway Co., whose property was recently purchased at a foreclosure sale by Napoleon Hill and J. C. Neely, of Memphis, representing the bondholders, it was resolved to reorganize the company immediately on the formal transfer. The property includes three coke iron furnaces at Sheffield and mineral rights in neighboring counties. It is the stated purpose of the interested parties to put the furnace plant in operation at an early date. —Baltimore *Manufacturers' Record.*

The Lane & Bodley Co., Cincinnati, Ohio, during the week ending June 6, received orders for one five-hundred horse-power high-pressure Corliss engine for the Des Moines Electric Street Railway Co., Des Moines, Iowa, one five-hundred compound condensing engine, with surface condenser, for the Cincinnati Electric Light Co., Cincinnati, Ohio, and one four-hundred horse-power for the Evansville Gas & Electric Light Co., Evansville, Ind. Three such orders in one week show not only the demand for engines by electric light and power companies, but also the enviable reputation of this old company, which has been in the business for more than half a century.

A Toronto (Ohio) dispatch says: Representatives of a second English syndicate have been here, securing options on the remaining sewer pipe works of this place and vicinity, and, so far as can be learned, have been successful in securing all of them Syndicate No. 1 gobbled up nine works, the most of them being in Ohio and West Virginia. They left a few, which have been taken in by the other crowd, and all will be controlled by this one head of big capitalists. The present owners still retain stock in the concerns, and the works will be run by the present managers under orders from headquarters. The syndicate has purchased three-fourths of the stock and the remainder will be held by home capital.

The first iron and steel bridge works in the State of West Virginia has been so quietly developed from an ordinary machine shop that it has never been noticed, and would probably never have been heard of had it not been recently the successful bidder on several county bridge jobs down in the lower part of that State. Ingram & O'Neill are the proprietors of the plant, and it is located at Huntington. They now have all the appliances, machinery, etc., for building bridges complete, and are now engaged on four new bridges, one of which goes to Kentucky, and the other three to points in West Virginia. Their business is growing, and they recently built an addition to their shops.—*American Manufacturer.*

A Haverhill (Mass.) dispatch says: J. H. Winchell, whose shoe factory has been the center of all the labor agitation for the past few months, and which is even now under the ban of the union, proposes to re open his factory at an early date on the profit-sharing plan. He will employ only union men in his factory, but they shall be organized as the Winchell Shop Union, in opposition to the International. Mr. Winchell says he will have his own shop committees, and while the shop union can prevent any reduction in prices, all troubles can be settled without any outside interference. The strikers regard this as a sign of weakening on the employers' part, and will not take any step toward a compromise, but will wait for Winchell to take the first step. Some manufacturers anticipate that this movement will be made general, and other shops in the city strike. One manufacturer declares that if this is done he will discharge every union man in his employ and run an absolutely free shop. This has been tried before in Haverhill, but has caused a bitter fight, as no doubt it would this time.

On Decoration Day, experimental trips were made on West Lake street, between Western avenue and 40th street, in order to adjust to the track the new motor which is soon to be operated on the West Side street railways. Attached to one car, numerous test trips were made by the motor, with entirely satisfactory results. This motor, known as the Connelly gas motor, is certainly one of the most ingenious of inventions. In outline it consists of a tank of naphtha, from which a pipe conducts the arising vapor down to a cylinder fitted with a piston. An electric spark causes an explosion of the vapor, setting in motion the piston, which in turn rotates a large drive wheel. So far it is exactly the principle of the steam engine, the explosion of the vapor being the operating force, instead of steam. It is to make this effective, reliable and easily handled, that devices innumerable have been attached. One of these is the device of surrounding the naphtha tank and the cylinder each with a connecting water jacket. The explosions of vapor in the cylinder heat the water in the jacket surrounding it. This heated water rises into the water jacket surrounding the naphtha tank and accelerates the vaporizing of the naphtha. An interesting device is attached for regulating both speed and direction. Gearing on the periphery of the drive-wheel gives motion to a small dynamo generating the electricity, which causes the explosion within the cylinder. The rapidity of these explosions, which varies with the load to be removed, is regulated automatically by a governor connected with the drive-wheel.—*Industrial World* (Chicago).

The Mechanical Engineers.

The next paper presented at Wednesday afternoon's session was by Prof. John E. Sweet, on the "Effect of an Unbalanced Eccentric in Shaft-governed Engines," which was published in full in our issue of May 15.

Mr. Jesse M. Smith in discussing the paper expressed surprise at the position assumed by the circle as drawn by the freely moving weight, and was inclined to attribute its position at one side of the center of shaft, instead of beneath it, to the effect of unbalanced pressure upon the valve-stem. He related his experience with a shaft-governed engine, which showed some peculiarities in the indicator diagrams, the disturbance being similar to what would be expected from such a variation of the path of the eccentric as had been observed by Prof. Sweet. Suspecting that it was due to unbalanced pressure on the valve-stem, he arranged to run the stem through the steam-chest at the back, providing it with a stuffing-box the same as in front. The distortion disappeared.

Prof. S. W. Robinson, who was not present at the presentation of this paper, discussed it on Friday morning. For lack of time his discussion could not be presented in full, and we cannot give it; but he took the ground that the phenomenon was due to want of isochronism, illustrating his position by blackboard sketches to show that both analysis and some experiments which had been conducted by him were at variance with the results obtained by the author of the paper. The next paper was by W. W. Bird, entitled

"AN OPEN-END MERCURY COLUMN FOR HIGH PRESSURES.

The mercury column described in this paper is the result of an attempt to provide for the testing of spring gauges used in connection with the work carried on in the Mechanical Laboratory of the Worcester Polytechnic Institute.

The object was to design a column which would give pressures from atmospheric to 200 lbs. to the square inch, or higher if needed; it should be sufficiently accurate for engineering purposes and at the same time not expensive, and, if possible, it should provide for taking readings at one convenient point.

Referring to Fig 173, *A A* is a small iron tube connected at the lower end with the glass tube *B*, which in turn is connected by a flexible tube *C* with the gauge or gauges *G G*. They are fastened to the carriage *D*, which runs on the rod *E E*. The tube *A A* in this case is made up of four sections, each section being of sufficient length to give a pressure of fifty pounds when filled with mercury at 62° Fahr.

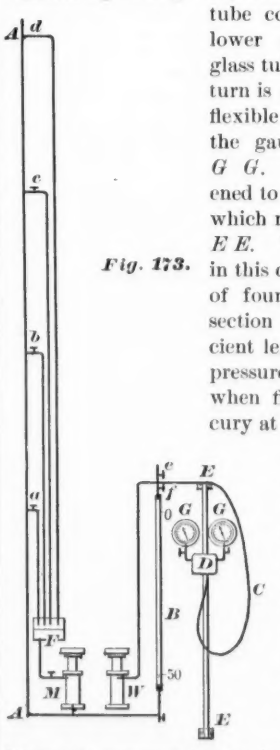


Fig. 173.

The method of operating is as follows: By means of the pump *M* mercury is forced into the column. It rises in both the iron and glass tubes, the cock *e* being open. When the mercury in the iron tube reaches the end of the first section it passes through the valve *a* and down an overflow pipe to the collector *F*. This fixes the zero mark on the scale. Water is then put in at the top of glass tube by means of the pump *W*, and fills the top of the glass tube and the flexible tube *C*. Closing the cock *e*, more water is forced in, and the mercury in the glass tube is displaced, thus forcing more into the iron tube, the result being an overflow at the valve *a*. Thus the mercury can be lowered to any desired reading between 0 and 50,

while the level in the iron tube remains the same, the gauges being moved up or down to correct for the column of water. The operator at any time can easily assure himself of the level of the mercury in the iron tube by forcing in more mercury until some comes down the overflow.

When pressures from 50 to 100 lbs. are desired, the gauge is corrected or its correction noted, if any, for 50 lbs., by the first section, the valve *a* closed and mercury forced in until it comes down the overflow from the valve *b* and stands at 0 in the glass tube, the water having been returned to the pump or allowed to escape. The gauge being brought to the proper place, the reading should be 50, or show the same as at the end of the first section. This gives a means of checking the measurement of the tube from *a* to *b*. The operation is now the same from 50 to 100 as from 0 to 50. And by closing the valves *b* and *c*, pressures from 100 to 150 and 150 to 200 are obtained. More sections can be added if higher pressures are desired.

By closing the valve *f* two gauges can be compared, by changing the water pressure with the pump *W*.

By some simple means the valves *a*, *b*, and *c* could be opened and closed from below, and thus a gauge could be tested from 0 to 200 or higher, with an open mercury column, without going up more than eight or ten feet to take readings.

The column at the Institute was built in general after this plan and is giving good results.

Prof. Jacobus, in discussion, sketched on the board the column used at Stevens Institute, saying that he might, at a future time, give a more complete description of it than was then possible.

The next paper, which was by Prof. Geo. I. Alden, was read by the secretary in the absence of the author. It was entitled:

AN AUTOMATIC ABSORPTION DYNAMOMETER.

The desirability of maintaining a uniform load upon an engine used for experiments and tests, of accurately measuring the useful power developed by the engine, and of automatically regulating the rate at which energy is absorbed, led to the construction of the device herein described.

This dynamometer is essentially a friction brake, in which the pressure causing the friction is distributed over a comparatively large area, thus giving a low intensity of pressure between the rubbing surfaces. The pressure is produced by the action of water from the city pipes. Enough water is allowed to pass through the machine to carry off the heat due to the energy absorbed. The rubbing surfaces are finished smooth and run in a bath of oil. A valve operated by the slight angular motion of the dynamometer varies the supply of water, and consequently the pressure between the frictional surfaces, thus securing automatic regulation.

Referring to the drawings, *A* (Fig. 185) is an iron disk keyed to the crank-shaft *B*. The sides of this disk are finished smooth, and each side has one or more shallow radial grooves, as shown at *X* (Fig. 183). The outer shell consists of two pieces of cast-iron, *C C*, bolted together, but held at a fixed distance apart by the iron ring *D*—whose thickness is the same as that of the disk *A*—and by the edges of the copper plates *E E*. Each of these plates at its inner edge makes with the cast-iron shell a water-tight joint by being "spun" out into a cavity in the iron, and held by driven rings *F F*. Thus between each copper plate and its cast-iron shell there is a water-tight compartment, *W W*, into which water from the city pipes is admitted at *G*, and, passing to the opposite compartment through passages, as shown at *O*, is discharged through a small outlet at *H*.

The chamber *M N N* is filled with oil, which finds its way from *N* to *M* along the grooves in the disk *A*.

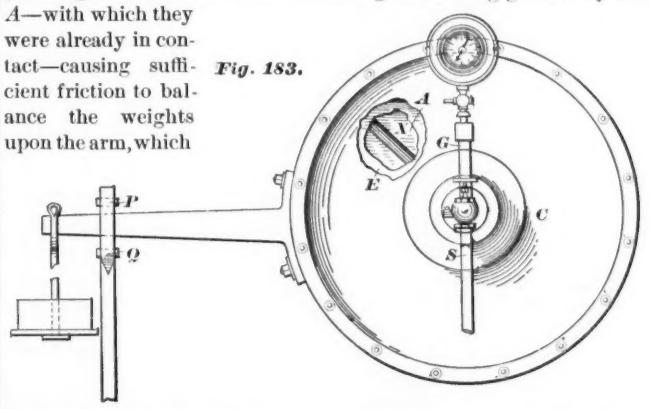
The shaft is free to revolve in the bearings of the cast-iron shell *C C*. The shell has an arm carrying weights, as shown in Fig. 1. The arm has its angular motion limited by stops at *P* and *Q*

An automatic valve at *V* (Fig. 184), and shown in sections (Figs. 186 and 187), regulates the supply of water to the machine.

The valve consists of two brass tubes fitted one inside the other, but free to revolve relatively to one another. The inside tube has one end closed. Each tube has slots parallel or nearly parallel to its axis. One tube connects with the supply pipe *S*, the other tube with a pipe rigidly fixed to the brake, and communicating with one of the compartments *W*. A flexible tube, *R*, encloses the whole. The valve is so adjusted that a slight angular motion of the brake varies the free water passage through the slots (see Fig. 187), and the aperture at *H*, through which the water is discharged, being small and constant, the pressure of the water in the chambers *W W* is thus automatically varied.

The dynamometer is operated as follows: The chamber *N N M* being filled with oil, weights are suspended from the arm to give the desired load. The engine is started, and, when up to speed, a valve is suitably opened in the water pipe leading to the automatic valve *V*, which latter being open, allows water to pass to the compartments *W W*. The pressure of this water forces the copper plates against the sides of the revolving disk *A*—with which they were already in contact—causing sufficient friction to balance the weights upon the arm, which

Fig. 183.



then rises. This motion operates the automatic valve, checking the flow of water to the brake, and regulating the moment of the friction on the disk to the moment of the weights applied to the arm of the brake. The first trial of the machine gave remarkable results; the arm standing midway between the stops, with only a slight and slow vibration, and this without the use of a dash-pot. The water seems a little sluggish in its action in response to the motion of the regulating valve, so that there is no sudden vibration of the arm, and the load is practically constant.

Fig. 185.

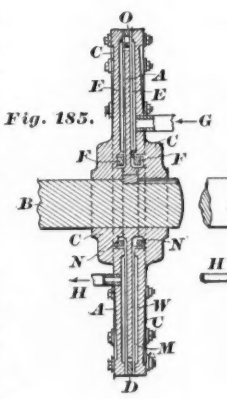


Fig. 184.

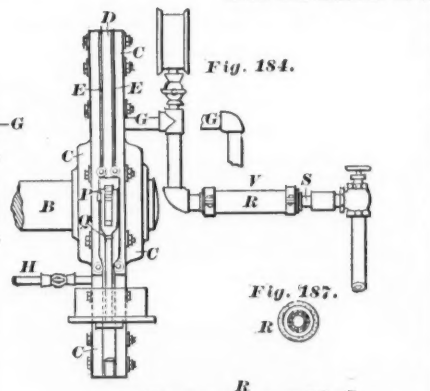
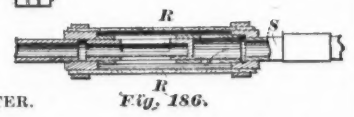


Fig. 187.



ABSORPTION DYNAMOMETER. *Fig. 186.*

The low intensity of pressure at the friction surfaces, their smooth finish and perfect lubrication, a constant temperature maintained by a uniform flow of the cooling water, and the sluggish action of the water in response to the slight motions of the regulating valve, all are favorable to the unusual steadiness and complete regulation realized in the actual operation of the brake.

No discussion followed the reading of this paper, and at its conclusion the topical questions were taken up until time for adjournment. The first one, "Does a boiler steam more freely if the tubes are arranged so as to be further apart, horizontally, in the upper rows than in the lower ones?" brought out very little in direct answer to the question, though several members showed how the tubes had been arranged, with the object of securing freer steaming. The second question related to earthwork dams, and elicited no response. The next inquired how fast the dash-pot apparatus, such as is used on the Corliss engine, could be worked? Mr. Barnes said he had known them to work satisfactorily up to 100 per minute. Mr. Raynal had run them up to 125, and thought that with a short lift (which he recommended) they could be worked up to 200. Mr. Edgar Penney had known the vacuum dash-pot to be worked satisfactorily at 240 revolutions.

The next question asked for the comparative advantages of horizontal and vertical bending rolls. The president said that he had seen vertical rolls working while abroad last summer, and that the plates seemed to be handled with much ease. Mr. J. W. See related an instance in which he had seen horizontal rolls used in connection with a traveling crane by starting the sheets through the rolls, stopping them and hitching the crane onto the projecting end, and using its power to bend the sheets about the rolls. He said it broke the rolls all to pieces, but the roll maker had to stand that, and he didn't know but that this might be considered as among the advantages of horizontal rolls.

At Wednesday evening's session three papers were presented, relating to chimney draught, one of which, by Prof. J. Burkitt Webb, we published in our issue of May 22, the balance being for the most part too mathematical to be of general interest.

Mr. Barrus' paper on "A Universal Steam Calisimeter," which we hope to find room for soon, elicited not so much discussion as warm commendation from the members, the author being greeted by a round of applause at the conclusion of his presentation of it.

Topical questions were then again taken up, the only one presented at this session which brought out much in reply, however, being that in relation to the use of power molding machines. Mr. Edgar Penney saying that he had used a machine constructed much after the manner of a drill-press, with very good results. The flasks, which were 18 inches square, were placed on the table, and the plate by which the ramming was done was attached to a shaft corresponding in position to the spindle of the drill. It was match-plate molding done in snap flasks, and was done much faster, and with much more even ramming than had been done by hand.

At the closing session, held on Friday morning, several papers of interest were presented, some of which we have already reprinted. That by Mr. H. H. Suplee, on "Equilibrium Arch Curves," was illustrated by models made of pine blocks, which the author put together on the stage, showing that they were stable without abutments, that pressing the key into place separated the entire arch from the supporting center, so that the latter could be drawn out, and that they differed in these respects from the common arch, a model of which was also constructed to illustrate the difference. The author showed that the curve was the same as that assumed by a chain, suspended from each end and uniformly loaded.

The final paper, by Prof. Jacobus, on "The Effective Area of Screws," brought out an animated discussion, in which Chas. E. Emery took the position that the efficiency of screws was largely a question of the proper adaptation of screw to the boiler and engine. In experimenting with screws of different forms on the same vessel, it often happened that one particular screw would be better adapted to that particular engine than any of the others. If that happened to be a new form of screw it was concluded to be superior to the others, whereas in fact it might not be, except upon that particular vessel or one like it. Mr. Raynal referred to the difficulties of accurately measuring screws and said that where the pitch was measured from the drawings it was entirely unreliable; for by the time the variation of the pattern from the drawing, and of the casting from the pattern was taken into account it would usually be found that the drawing was very different from the actual screw.

Mr. Henning said that with some of the alloys now being used for screws, which admitted of the blades being made quite thin, the spring of the blades in action was in all probability quite considerable, so that the actual form when at work would differ very materially from its form when at rest. Prof. Jacobus in closing under the rules, called attention to the fact that his paper treated only of the effective area of screws, not of their efficiency, and said that the pitch was determined by measurement of the screws themselves, not of the drawings.

The president reported that the committee on a joint society of the different engineering societies had made favorable progress, and would probably be ready to report at an early date. He took occasion to comment favorably upon the movement for the organization of such a society, and thereby called out a very vigorous expression of opinion from Mr. Daniel Ashworth, opposing it on the ground of what he believed to be its aristocratic tendency. Mr. Ashworth believed that if the society took part in any movement to organize a society composed of members of the different engineering societies selected in accordance with some arbitrary standard, it would inevitably result in injury to the society.

Chicago's Third Fire-boat, "Yosemite."

Chicago's third fire-boat, Yosemite, was successfully launched on the 31st ult., from Miller Bros.' shipyard. The dimensions are as follows:

Length.....105 feet.
Breadth of beam..... 24 feet.
Depth of hold..... 9 feet.
Tonnage, about..... 150 tons.

The cost of the hull is about $12,000, and the entire cost, with machinery in, hose, etc., aboard, will be about $33,000. This is said to be about $2,000 less than the cost of Chicago's fire-boat Geyser. The new craft is a few feet longer than the Geyser, and has greater capacity in various ways. In appearance the two boats will look a great deal alike.

The engines and fire pumps of the Yosemite were built by Charles F. Elmes, of Chicago, who also furnished the machinery for the fire-boats Chicago and Geyser, and the Milwaukee fire-boat Cataract.

The Yosemite has two sets of propelling engines; they are double direct-acting, cylinders 18 inches diameter, 20-inch stroke. Propeller 8 feet diameter and 12 feet pitch.

With a boiler pressure of 120 pounds the engines are expected to make about 175 revolutions per minute. In the engine-room there are set athwartships two sets of duplex direct-acting fly-wheel pumps with steam cylinders 16½ inches diameter and 12 inches stroke, and water cylinders are 9½ inches diameter. Their combined power for fire duty is 6,000 gallons of water per minute, with eighty pounds boiler pressure.

The boiler is made of Otis steel; it is 16 feet long, and its cylindrical shell is 10 feet diameter. It contains 2,300 square feet of heating surface. It was built by J. Mohr & Sons, of Chicago.

On each side of the boiler there will be two 10-inch water mains, which are to be connected at the forward end of the pilot house by a bent pipe, on each side of which will be seven 3½-inch gates.

An iron tank is to be located in the forward end of the boat, capable of holding 800

gallons of water. This is a reserve supply of water to be used in localities where the water supply is of such a character as to render it unfit for steaming purposes.

The Yosemite will throw one 4-inch stream of water 450 feet, eight 2-inch streams 300 feet, two 3-inch streams 350 feet, or twenty 1½-inch streams 160 feet.

The new boat is expected to be ready for duty in about two months, and will undoubtedly give a good account of herself when an opportunity occurs.

Progress in Heating Cars by Steam.

The net results to date of the agitation for the banishment of the murderous car stove are given in concise form in a recent issue of the *Engineering News*, which has gone thoroughly into the subject, and ascertained as nearly as may be what roads have done anything in this direction, and how much. Tables and a railway map are published, giving the results. On 8,465 miles of railway all passenger trains run during the past winter were heated by steam from the locomotive. Companies operating 10,912 miles more have over half their cars equipped for steam heating. Companies operating 17,516 miles have from ten to fifty per cent. of their cars equipped, and companies controlling 54,550 miles have been conducting experiments. The total amounts to 91,443 miles controlled by companies which have at least made a beginning toward the abolishment of the car stove, and the substitution therefor of steam-heating systems supplied from the locomotive. These figures do not, however, represent fully the progress made, because the roads which have made most progress are mostly those having the heaviest passenger traffic. The tables given show that 7,391 cars have been equipped, which is nearly 25 per cent. of all the passenger cars in use in the country. Perhaps the most surprising result of the trials so far has been the case with which steam has been supplied. Most railroad men knowing the difficulty encountered in keeping up steam for making time with passenger trains, honestly thought that any use of steam from the locomotive boiler for heating purposes would inevitably result in a noticeable decrease in the efficiency so far as the main purpose of locomotives is concerned. It must now be concluded that this opinion was founded upon a misapprehension regarding the proportion of steam required for heating as compared with that required for the work of drawing trains; for out of fifty-seven companies giving answers to the question, "Does draught on locomotives cause appreciable increase in fuel consumption?" forty-one replied that it did not, five that it was "slight," and two "imperceptible." The New York, Providence & Boston replied, "Appreciable, but no difficulty about having steam enough." The Lake Shore & Michigan Southern said it was "appreciable where trains exceed eight cars." No tests of this matter are reported by the roads in answer to an inquiry for them by our contemporary, but it is fair to infer that practical results showed that tests were unnecessary, or they would have been made.

The reports respecting other difficulties show them to be slight, and it is made evident by this very creditable piece of work by the *Engineering News*, not only that the car stove is doomed, but that it is probable heating by steam from the locomotive will be the generally accepted substitute for it.

About Measurements.

We take the following from *Electrical Plant*, an English technical journal. Most of our readers will probably be able to name the writer:

"An old engineering acquaintance, not unknown to technical journalism, writes to us privately in a very interesting strain concerning several topics of at least indirect importance to electricians, and we think that some of our readers may enjoy a chance of sharing these remarks:

"Holland is a most interesting country. Amsterdam is as full of canals as one could wish. This makes a fine, open sort of city, but they counteract this by the narrowness of cross-streets and alleys—not more than a meter wide. Yes! no old yards for me now! I have to act on the square, or rather the cube, meter here. It is curious, though, to see how English measures come into the engineering here. Our dredger specification is a compound of metrical and English dimensions.

"The specified pressure is 90 pounds. The steam gauge registers kilos per square centimeter, the vacuum gauge reads in decimeters, the pump gauge in atmospheres; the indicator is English, in pounds per square inch, so that one has to go through a course of mathematical gymnastics, and spring from point to point like an Alpine goat, until, by bedtime, one's mind becomes lined over with hideous goblins, and the mystic figures 39.37 dance riot among claimants (ranging from 13.9 to 14.3) for the honor of translating pounds per square inch and kilos per square centimeter, until a 300-liter dredge bucket of blue clay is dumped on the top with a force of 2½ atmospheres, and then all becomes vacuous to the extent of 760$^{m/m}$, which the reverse side of my meter rule shows to be 29$\frac{7}{8}$ $\frac{1}{32}$ full bare, as I once saw a dimension of a boiler plate thickness written by an inspector.

"This science of numbers is very fine, and when decimal points run amuck on a quarto sheet of figures, as they are prone to do unless you know your probable answer, you are likely to spend all the beautifully saved time of the system in hunting for them, only to find that they mount up by fits and starts ten-fold or one hundred-fold, or suddenly retire to the far rear microscopically reduced, and you turn with relief to Rankine and read that a 'yard is the distance, etc., between two marks on a certain bar, etc., at Westminster,' or you can go to the Guildhall and measure it off by steps; and the great arc of the meridian becomes as dim as an arc lamp in a fog, and the brilliancy of the metrical idea proves no more penetrating than that of said arc lamp; and so you fall asleep and dream of Noah's ark, and the pyramids, and Piazzi Smyth, and wonder if Noah's ark was the arc of the meridian, and if it was really ten million meters long, or whether it was a switchback railway made to carry the pyramids from the North Pole to the equator, and you can see the old ark sailing up the Zuyder Zee, and wonder where it will perch; and this makes you dream of Irish measures, and you sigh for the sixpence which the Irish cab driver charged you to ride the forty perches from the railway station to the hotel; and when you wake you are oppressed with a feeling that you have to ascertain how many liters there are in a pound per square inch, and the number of gallons in an arc of the meridian, and what vacuum per square centimeter is equivalent to forty perches per square inch of a column of mercury five liters long."

Spring Birds Build Homes in Electric Light Globes.

A new use has been discovered for electric light globes. The spring birds have found that they make excellent places in which to build their nests, sheltered as is the inner space from the winds and storms, and many a lively and lovely courtship may be seen almost any day by glancing at the top of the tall poles.

The new comers perch upon the edges of the globes and peep and twitter to one another as they make their connubial arrangements. Then they may be seen bringing their twigs and bits of straw and twine preparatory to beginning housekeeping.

A day or two later and the domicile is all ready for occupancy. One may see the little nests from below through the glass.

The dear little fellows seem happy and contented, although they live in the full glare of light by day and by night.

A bird's nest one expects to find hidden beneath a branch in some cool, shady spot,

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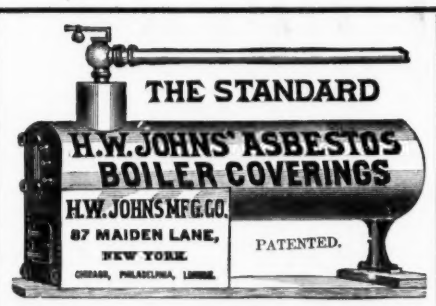

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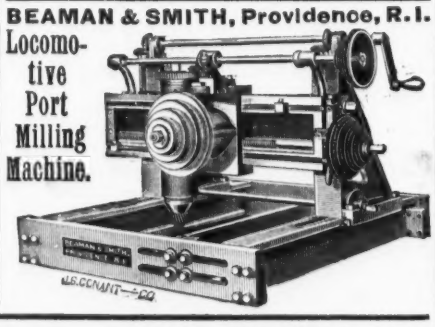

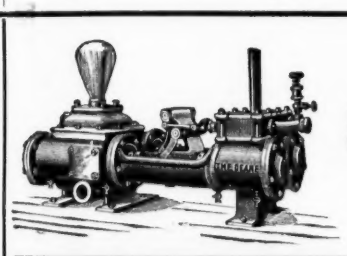
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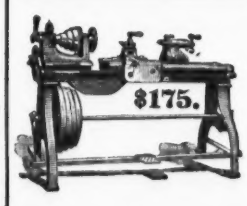

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WILMINGTON, DEL.,
MAKERS OF
Metal Working Machine Tools
FOR
Machinists, Engineers, Locomotive Builders, Bridge Builders, Railroad and Car Shops, and Iron and Steel Works Generally.

and not in so conspicuous a place as this. But if the birds are happy there it is to be hoped that the faithful employes of the electric-light companies will not interfere with them.—*Boston Advertiser.*

An iron bridge, 120 meters in length, which was being thrown across the river Lot at Boissé Puchot, in France, was completely overturned last week by a violent hurricane. The bridge had not been fixed. Three men were at work on the structure; one was killed, and the others escaped with difficulty.

One year ago the 6th of June, Seattle, Washington, was visited by a fire that destroyed $12,000,000 worth of buildings. In one year $6,000,000 have been rebuilt.

Machinists' Supplies and Iron.

NEW YORK, June, 14, 1890.

Iron—American Pig.—The market has developed no new features of late worth mentioning, and quotations remain unchanged. Southern brands are held with slightly more firmness, and a little more interest is taken in the market by consumers.

We quote Northern brands No. 1 Foundry, $18 to $18.50; No. 2, $17 to $17.50. Southern No. 1, $17 to $17.25. Southern No. 1, Soft, $16.50 to $16.75; No. 2, $16 to $16.50.

Scotch Pig—The transactions have been small.

We quote Eglinton, $19.25 to $19.50; Dalmellington, $21.50; Summerlee, $23 to $23.50; Coltness, $24 to $24.50.

Bar—The demand has been fair during the week, but prices rule in buyers' favor.

We quote Common, $1.85; Medium, $1.90; Refined, $1.95 to $2 for round lots on dock.

Copper—The consumption at present is very heavy, and the market is firm. Lake Superior Ingot is quoted at 15¾c. We quote Arizona at 14c. to 15c., and common casting brands at 13½c. to 14¼c.

Lead—An advance has taken place owing to increased demand from consumers. Present quotations are 4.40c.

Spelter—The market has been fairly active, consumption keeping well up with production. We quote Prime Western, 5.60c. to 5.70c.

Tin—No change of importance is to be recorded since our last report. Prices have ruled at 21.40c. to 21.70c.

Antimony—The market has ruled quiet but firm. We quote Hallett's, 19½c. to 20c.; Cookson's, 23c.

Lard Oil—No change in price has taken place. We quote 53c. for Prime.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—A lot of good machinists. Address Frick Company, Waynesboro, Franklin Co., Pa.

Wanted—A first-class pattern maker. Steady work and good pay to the right man. Address Box 16, AMERICAN MACHINIST.

Foreman wanted to take charge of a machine shop; competent to manage men, and exp'd in steam engine building. Address N. M., AMERICAN MACHINIST.

Pattern Maker—first-class—wants a situation to have charge. 16 years' experience; age, 32; one year as foreman. Box 23, AMERICAN MACHINIST.

Wanted—A first-class pattern maker; one acquainted with saw-mill machinery. Address D. J. Murray Mfg. Co., Wausau, Wis.

Wanted—Good machinists and moulders at good wages with steady employment. Address Ottumwa Iron Works, Ottumwa, Iowa.

Machine shop foreman wants a change; experienced on steam engines and general jobbing. Address W. C. M., AMERICAN MACHINIST.

Wanted—Five or six good vise hands, Scotchmen preferred. Permanent employment to the right men. Apply to Erie City Iron Works, Erie, Pa.

Wanted—A first-class foreman to take charge of about 40 men building iron working machinery. Address Box 28, AMERICAN MACHINIST.

Wanted—Six first-class machinists and two pattern makers; steady work. Rents and living cheap. Address Haxtun Steam Heater Co., Kewanee, Ill.

Wanted—A few first-class machinists. State experience, age, habits, etc., and give reference. The Canton Steam Pump Co., Canton, O.

Capable young man wants position as draftsman or assistant sup't; exp'd on engines and general machinery. Address Box 31, care AM. MACHINIST.

Wanted—Reliable, first-class, experienced machinist for all-around work. Address, stating kind of work familiar with, wages wanted, etc., for steady work year to year, Box 29, AMERICAN MACHINIST.

Wanted—Two good die makers for drawing and stamping dies for brass. Steady work and good wages to first-class men only. Edward Miller & Co., Meriden, Conn.

Young man, well posted in mech. drawing, and 2½ years in carpenter shop, handy, steady and reliable, would like to learn pattern making. Box 30, AMERICAN MACHINIST.

Machinists Wanted—First-class floor hands and fitters of large experience and of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, O.

Draftsman Wanted—Presses, dies and general machinery. Write, stating age, where last employed, and salary expected, to the Dover Machine Works, Dover, Delaware.

Wanted—Foreman for small brass foundry within 150 miles of Chicago. One used to getting out first-class snap flask and moulding machine work. State age, experience and salary expected. Apply to C. S. H., AMERICAN MACHINIST.

Wanted—First-class tool and vise hands at the Chester Foundry & Machine Co., Chester, Pa. Also first-class fitters on heavy engine and machine work. Steady work and liberal compensation guaranteed.

Wanted—A first-class tool maker, competent to make and maintain shop tools, jigs, reamers, etc. Steady work and good pay to a capable and energetic man. Address, with references, The Westinghouse Machine Company, Pittsburgh, Pa.

Wanted—A foundry foreman; a man of steady habits, having experience in handling men, the making of heavy castings in dry and green sand. Apply, stating reference and experience, Lewis Foundry and Machine Co., Limited, Pittsburgh, Pa.

Wanted—First-class machinist, accustomed to close and fine work, and capable of making heads for the Adams automatic bolt threading machine. Steady work and good wages. Only an A1 man need apply. Address, with particulars, Capitol Manufacturing Company, 125 to 137 Rees street, Chicago.

Wanted—One or two first-class moulders to work on general castings, both dry and green sand. Location, 50 miles from Pittsburgh, Pa. We will pay standard wages to good, sober, practical mechanics. Don't apply unless you can fill the bill, as we will discover it very soon. Address "Foundry," AMERICAN MACHINIST.

Wanted—A first-class machinist, with capital, to take stock in the Fosmir Iron Works. One with experience to take charge of blacksmith and machine shop. A middle-aged man with plenty of experience preferred. A good opening. Address, for further information, J. F. Fosmir, Station C, Box 144, Los Angeles, Cal.

Wanted—A good general machinist, a boiler maker competent to lay out work, and a blacksmith who can do oil-well work. Strictly sober men wanted. Steady work with chance of advancement to the right men. Address, stating age, experience, and wages expected, The American Foundry and Machine Co., Bowling Green, Ohio.

✝ MISCELLANEOUS WANTS ✝

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Cheap 2d-h'd Lathes & Drills. S. M. York, Clev'd, O.

Koopman's Scales for quick measurements.

Just out; aluminum-steel hack-saws, hard but not brittle. Crescent Mfg. Co., Cleveland, Ohio.

New catalogue of engineers' specialties free. Crescent Mfg. Co., Cleveland, Ohio.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

Turned and Highly Polished Iron and Steel Shafting a specialty. Merwin McKaig, Cumberland, Md.

Complete list of our Scales and other new tools for 2c. stamp. A. T. Koopman, Chicago.

Wanted—Customers for our new Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

2nd-hand machinery, in good order; very cheap. Maslins, 165 First street, Jersey City, N. J.

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Lord & Co., P. O. Box 1262, Phila., Pa.

Wanted—Second-hand cutting off machine (small size) in fair order. Give size, condition, maker's name, and price. Address Moseley & Co., Elgin, Ill.

Wanted—To buy second-hand lathes, planers and shapers of all sizes. Must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

For Sale—A first-class small machine shop in Ohio. Large business on engines, etc. On leased ground. Will sell at a bargain on long time if sold at once. Ill health cause of selling. Address E. E., South Oil City, Pa.

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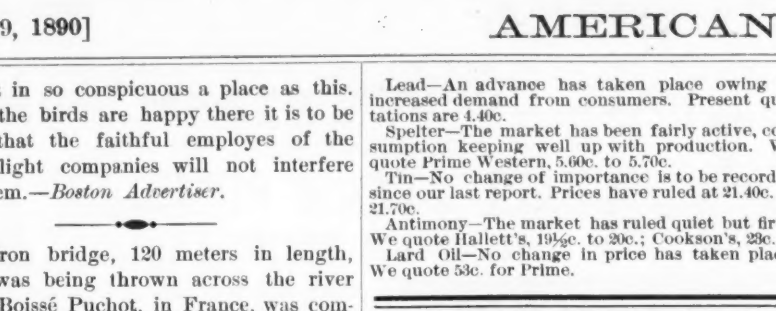

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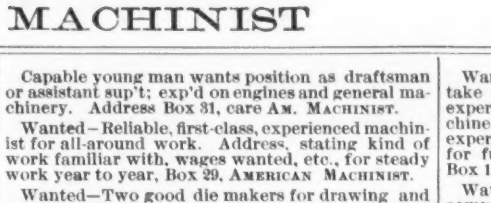

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2	⅞	.70	11	2½	1.45
3	1	.70	12	3	1.60
4	1⅛	.80	13	3½	1.80
5	1¼	.80	14	4	2.10
6	1⅜	.95	15	4½	2.75
7	1½	.95	16	5	3.25
8	1¾	1.10	17	5½	4.00
9	2	1.20	18	6	5.00
1 Set to 2 in.		7.80	Full Set		31.10

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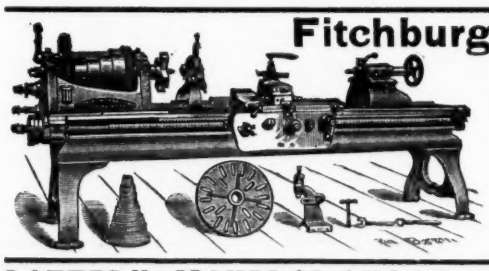
Fitchburg Machine Works,



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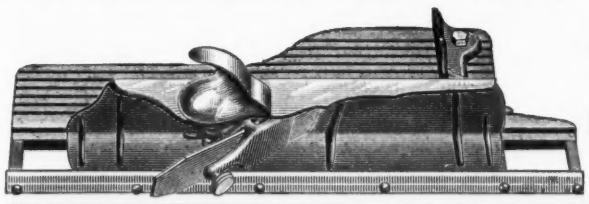

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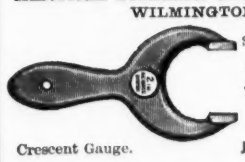

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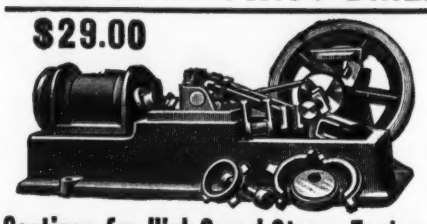

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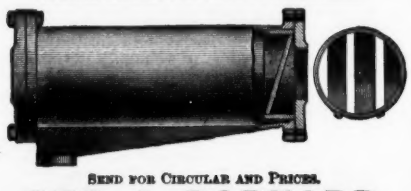

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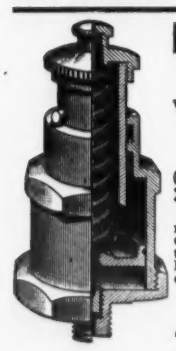

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1886.

Pattern Making, Various Articles on. By F. W. Barrows. Appearing in 29 issues.
Foundry Practice, Various Articles on. By Robt. E. Masters, appearing in 16 issues.
Strength of Different Mixtures of Cast-iron and Method of Testing. By Robt. E. Masters, April 24.
Foundry Practice, Articles on. By Foundryman. [L. C. Jewett.] Aug. 14, Sept. 25, Dec 18.
Foundry Practice, Articles on. By S. Bolland, May 8, 22, 29, June 26, July 10.
The Morton-Poole Roll Grinding Lathe. By Joshua Rose, J. G. Tramis, Geo. H. Babcock and C. A. Smith, July 3, 24, Aug. 7, 14, 21, Sept. 25.
Machine Shop Cost and Time Accounts. By A. J. Shaw, Henry Metcalfe and C. A. Burton, April 3, 17, May 8.
Tests of Iron. By David Spence, April 17, Oct. 30.
Traction on Grades. By A. B. Ropes, Oct. 30.
Wilson's Valve Gear for Locomotives, Oct. 30.
Casting Face-plates Face Up. By David Spence, Oct. 23.
A Job of Shaft Straightening. By F. L. Johnson, Oct. 23.
Inventory Valuation of Machinery Plant. By Oberlin Smith, Aug. 7.
Making a Cast-iron Sheave. By P. S. Dingey, July 31.
New Dredge Boiler designed by Norman Wheeler, July 17.
Core Oven with Rotating Back. By Thos. Wathey, July 24.
Universal Table for Lathe Change Gears for Screw Cutting. By Joshua Rose, July 24.
Gating, Clamping and Securing Chaplets. By Matthew Wiard, May 1.
Printing Frame and Manner of Making Blue Prints. By C. L. Redfield, July 31.
Some Pressure Tests. By C. O Sine, Nov. 27.
An Expanding Mandrel—Turning Tapers. By Chas. S. Beach, Nov. 27.
Core Making in Foundries. By David Spence, Nov. 20.
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Moulding a Screw or Worm without Cores. By George Allge, Sept. 11, 18.
Power Absorbed in Cutting Cast-iron. By James F. Hobart, Sept. 11, 18.
Moulding Screw Propellers in Loam. By Chas. A. Devlin, Sept. 18.
Dimensions of Wrought iron Pipes in England. By A. G. Brown, Sept. 4.
Truing Up and Replacing Milling Machine Centers with Accurate Alignment. By A. B. Landis, Jan. 16.
Methods of Working and Tempering Steel. By S. W. Goodyear, Jan. 9.
Slotting Tool. By J. J. Bingley, May 8.
How to Make Clean Solid Castings at Least Possible Cost. By Matthew Wiard, April 10.
Truing Milling Machine Centers. By W. R. Ballou, April 10.
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Screw Cutting Dies. By John J. Grant, April 10.
Some Handy Shop Tools. By Fred. H. Colvin, April 3.
Moulding Bells for Blast Furnaces in Green Sand Without Patterns. By Geo. O. Vair, April 3.
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Boring Deep Holes. By A. B. Landis, Mar. 27, May 8.
Working Steel and Iron. By S. W. Goodyear, Feb. 13.
Inventory Valuations of Patterns. By W. E. Matheson and others, Jan. 9, Feb. 13, 20, Mar. 6.
Making Cast-iron Half Boxes. By A. J. Shaw, Feb. 6.
Draining Steam Pipes. By W. E. Crane, Feb. 6.
Brazing and Welding Iron. By J. F. Hobart, Mar. 6.
Deep Holes by Continuous Boring. By A. B. Landis, Mar. 27.
Slotting Machine Tool. By Wm. Foster, Mar. 20.
Compound Engines for Stationary or Factory Purposes. By W. H. Hoffman, April 24, May 1, 22.
Engineering Subjects, Articles on. By W. H. Hoffman, Mar. 13, July 24, 31, Aug. 21, Oct. 9.
Self-contained Engines. By W. H. Hoffman, Feb. 27, Mar. 6.
Curving Qualities of Locomotives with High and Low Centers of Gravity, Oct. 16.
Making Large Spur Gear Wheels. By P. S. Dingey, Oct. 2.
Normal Theory of the Gear Tooth Curve. By Geo. B. Grant, Mar. 13, 20, Oct. 9.
Return Tubular Boilers. By Wm. Lowe, Nov. 27, Dec. 4.
Chimneys for Steam Boilers. By Wm. Lowe, Mar. 27, May 15. By F. A. Halsey, May 1.
Railroad Cost Cards and Expense Sheets, April 24.
The Milling Machine—Its Construction and Uses. By John J. Grant, Mar. 20.
Mechanical Arrangements of the N. Hudson County Cable Railway, Mar. 20.

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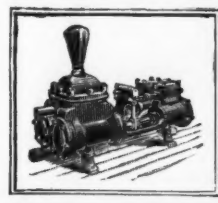

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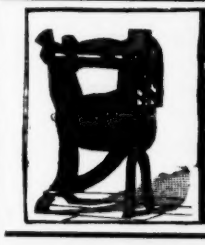

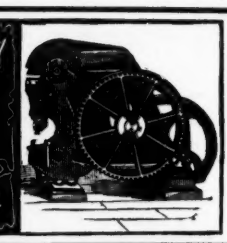

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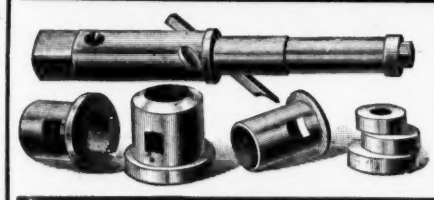

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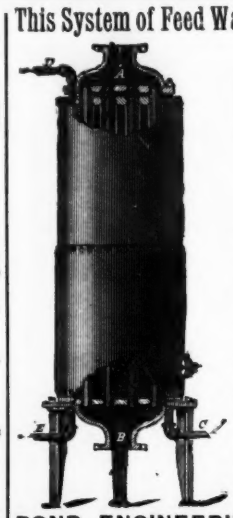

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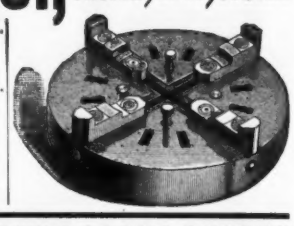

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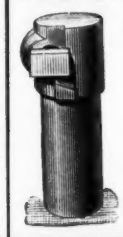

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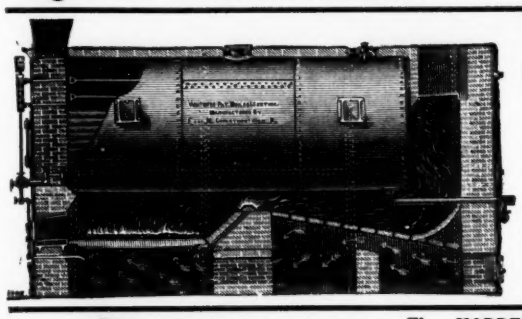

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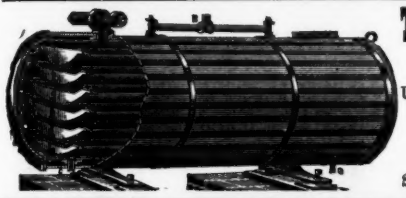

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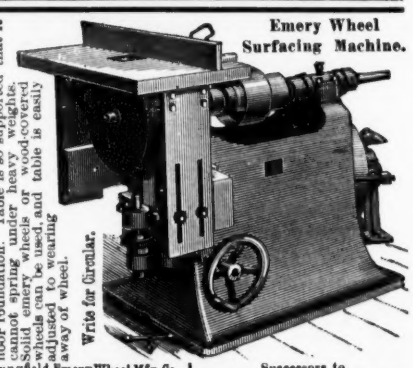

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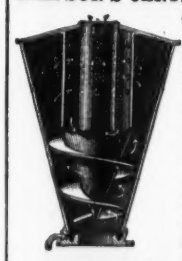

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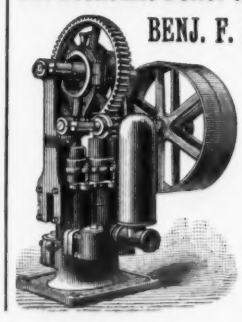

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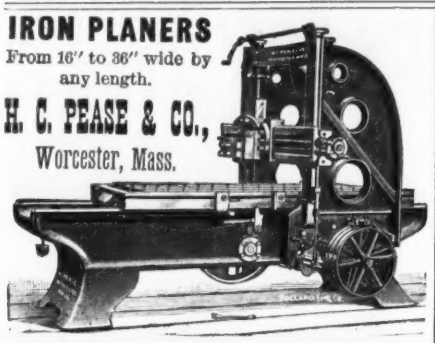

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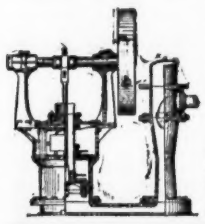

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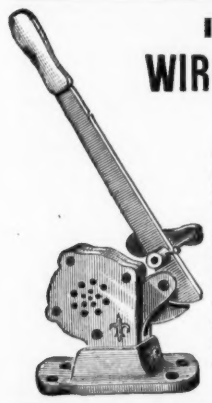

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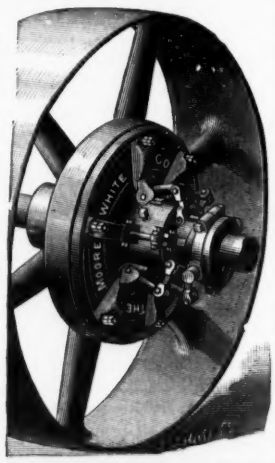

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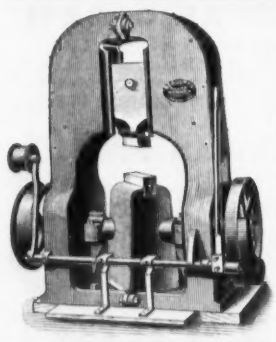

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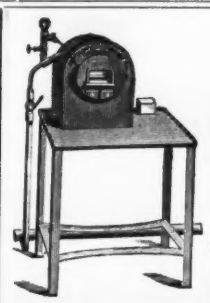

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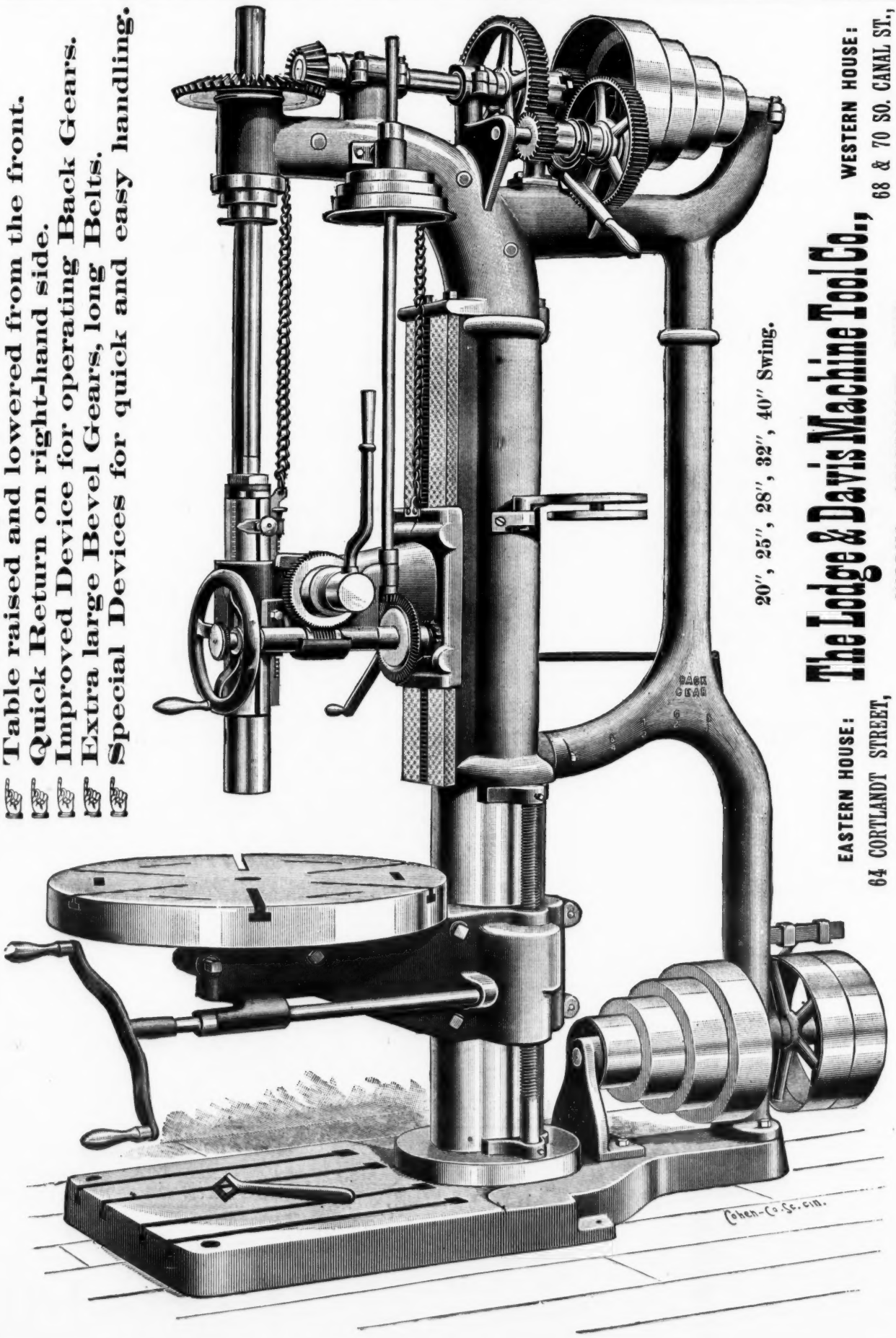

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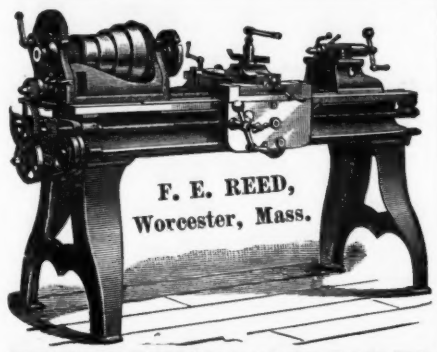

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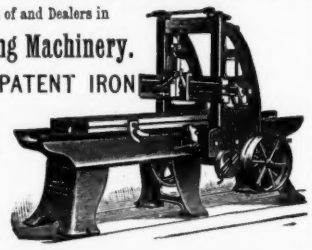

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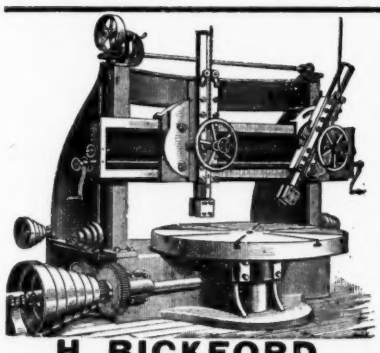

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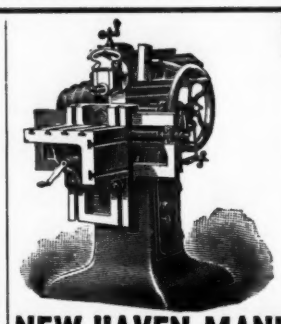

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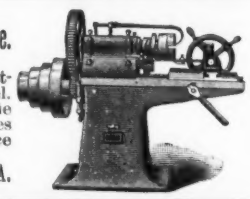

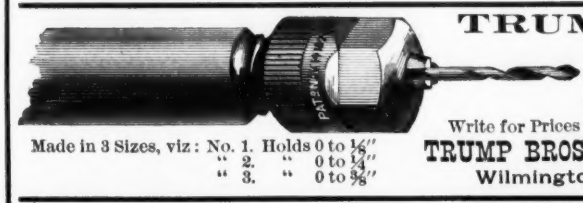

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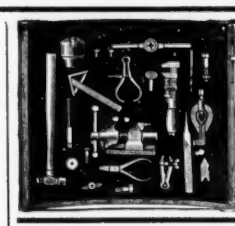

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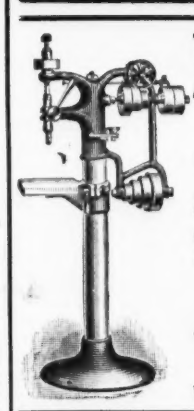

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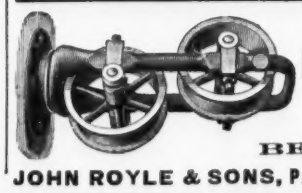

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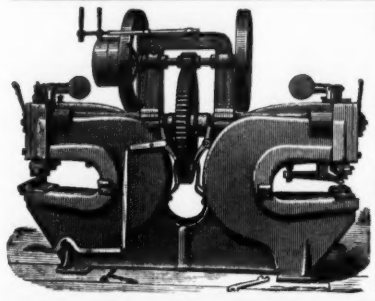

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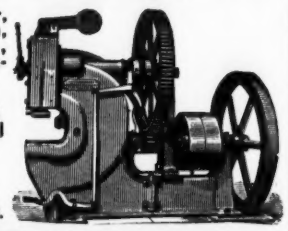

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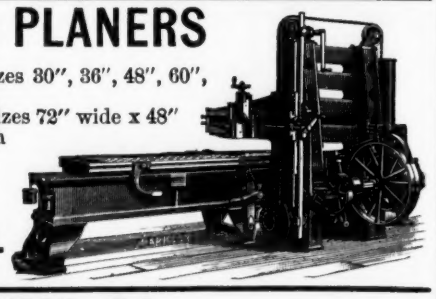

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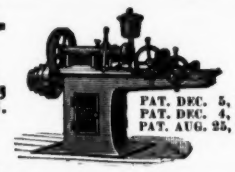

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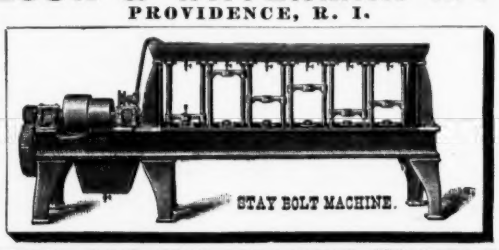

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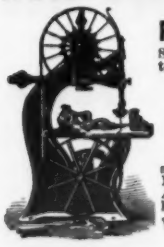

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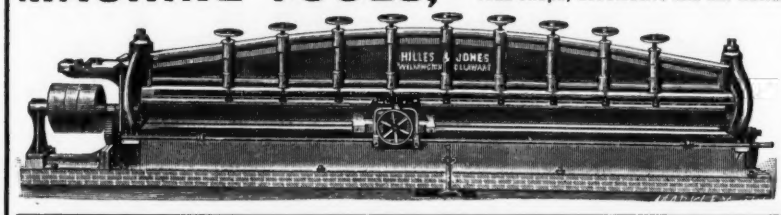

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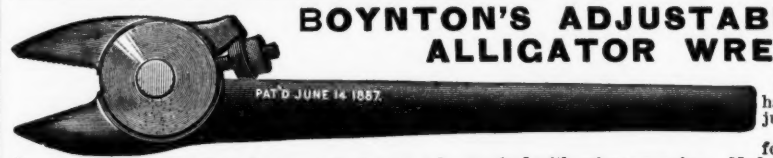

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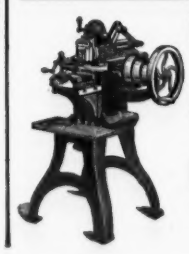

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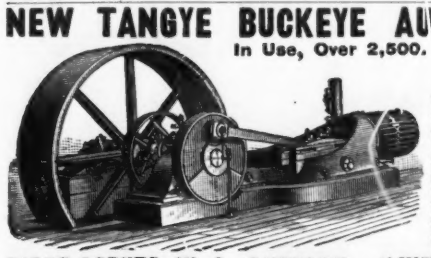

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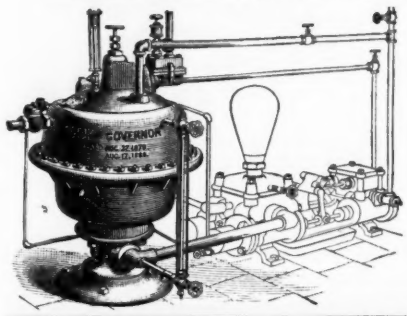

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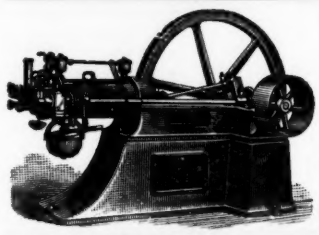

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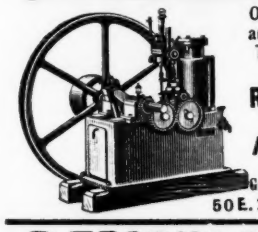

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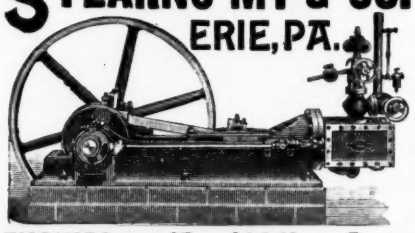

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" "	16 in. x 6-8 ft.	Prentice,	"
" "	16 in. x 8 ft	McMahon,	"
" "	18 in. x 8 ft.	Prentice,	"
" "	18 in. x 8 ft.	New Haven,	fair
" "	20 in. x 10-12 ft.	McMahon	new
" "	20 in. x 10-14 ft.	Wright,	"
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"	24 in. x 24 in. x 6 ft.	Lathe & Morse,	"
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Drills,	1 Spindle,	Garvin's,	" "
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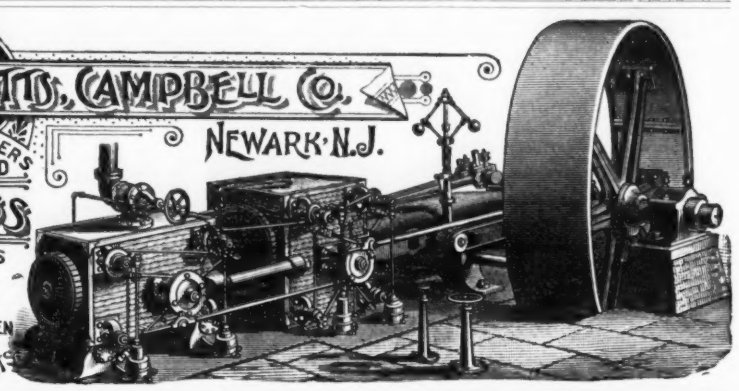

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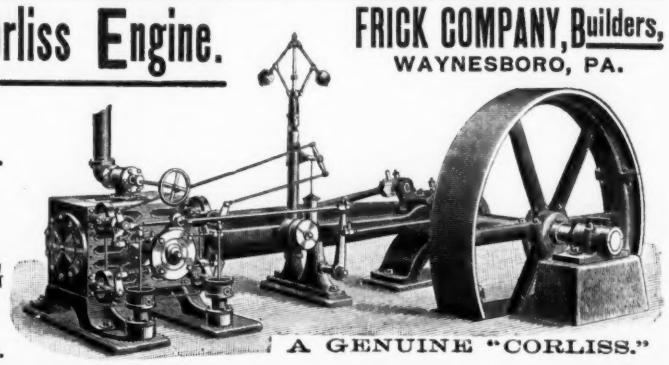

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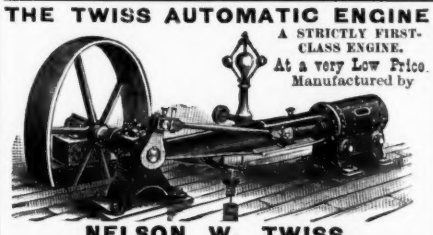

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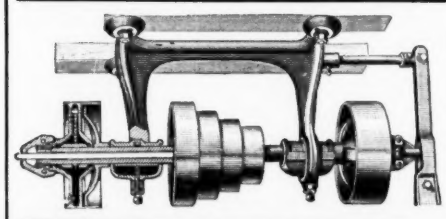

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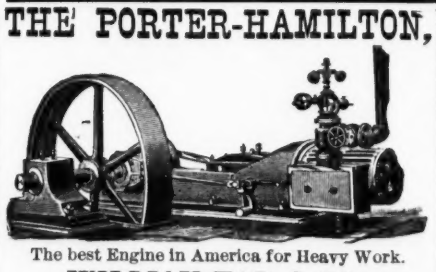

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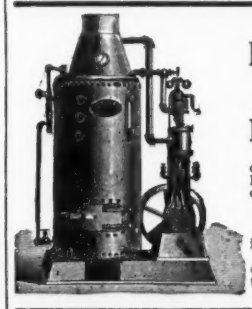

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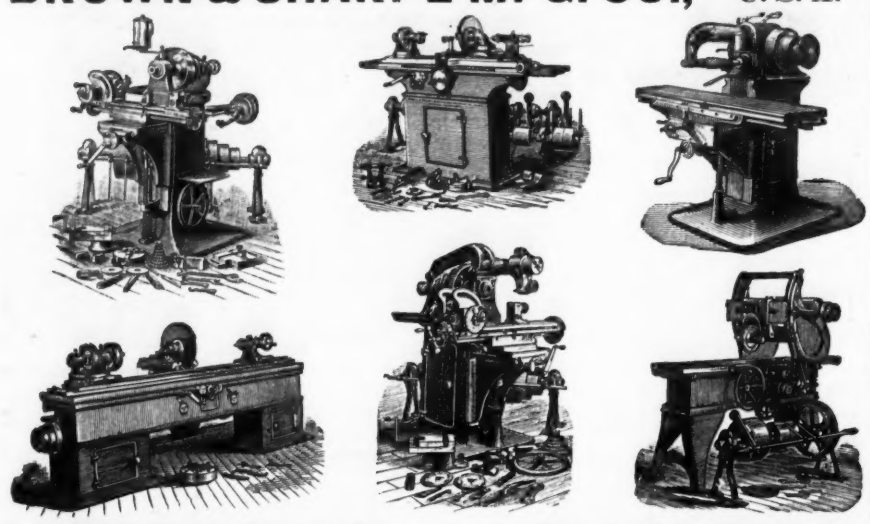

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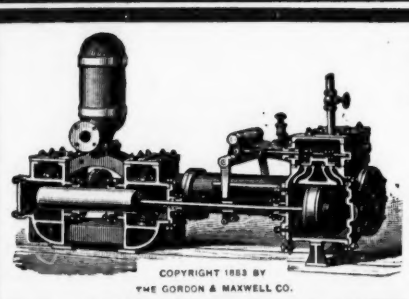

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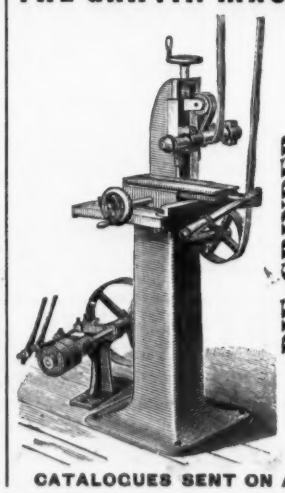

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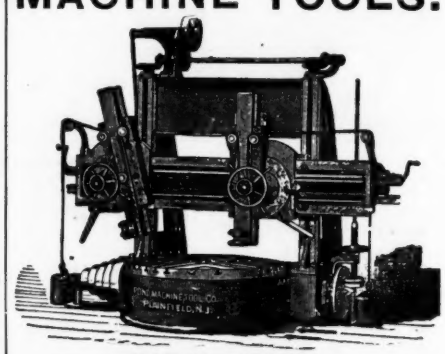

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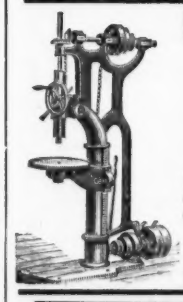

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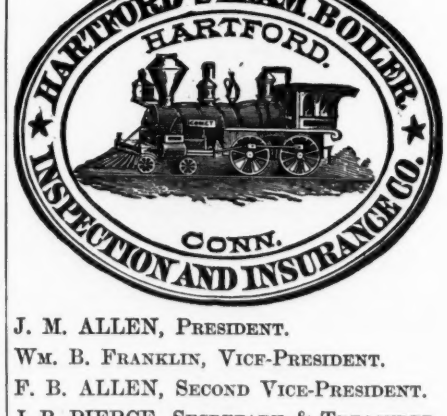

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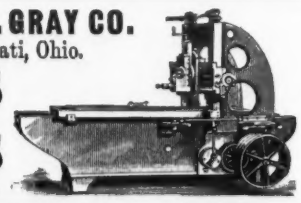

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